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April, 1938

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REPORT OF THE DIRECTOR

For the Year Ending
October 31, 1937

Connecticut
Agricultural Experiment Station
New Haven

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as of

October 31, 1937

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* In cooperation with the U. S. D. A.

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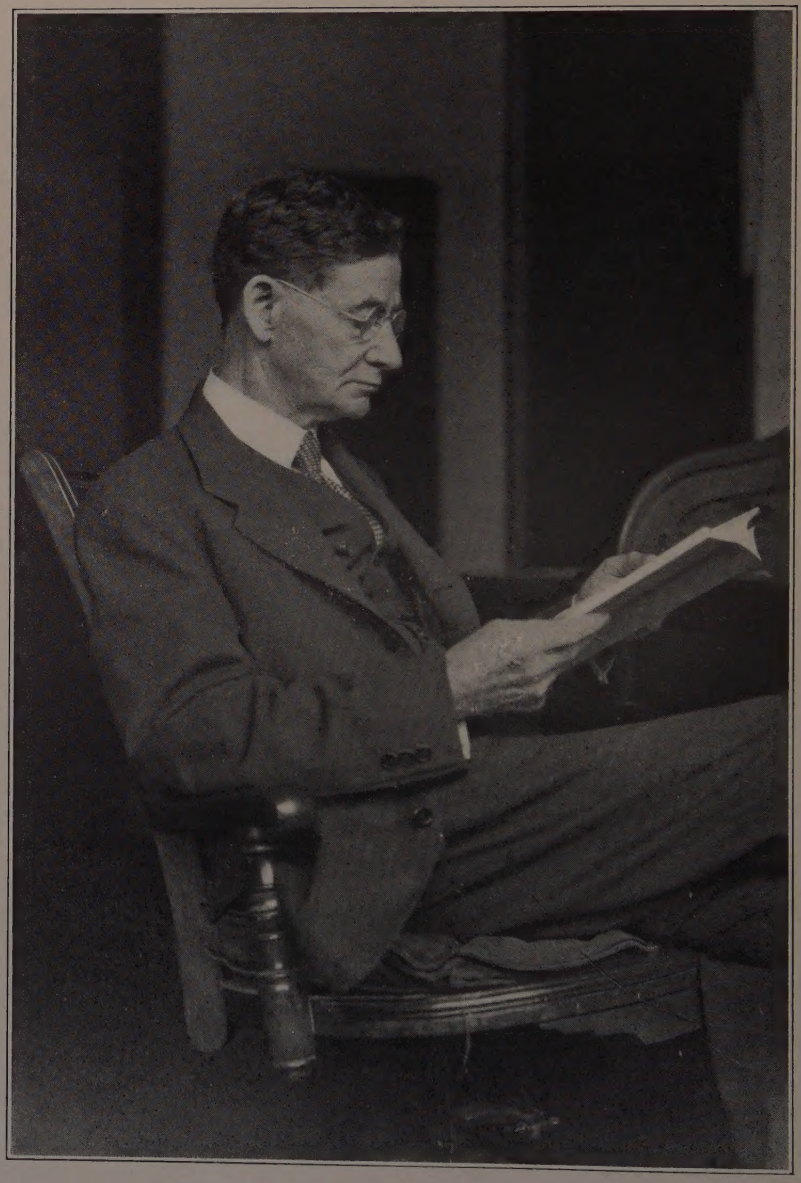

GEORGE PERKINS CLINTON M.S., Sc.D.

Station Botanist 1902 - 1937

REPORT OF THE DIRECTOR

For the Year Ending, October 31
1 9 3 7

To the Board of Control of the Connecticut Agricultural Station:

Although keenly aware of the problems with which American agriculture is now wrestling, the farmers of Connecticut have been less directly affected than those of some other regions. It is true that we have many unsolved problems of production; our markets are sought by competing producers from as far away as the Pacific Coast; the price of grain is of vital interest to our dairy and poultry men. However, we have long since made many necessary adjustments in land use, in type of farming, in the adoption of up-to-date methods, and can concentrate on new matters.

Perhaps some of the credit for the advanced position of our farming industry can be attributed to the fact that Connecticut was the first state in the Union to recognize formally the service that science can render to agriculture, and as early as 1875 established the Agricultural Experiment Station. Thus, more than two generations of Connecticut farmers have had at their direct service the tools that only science can offer.

Following Connecticut's lead, several other states established experiment stations. By 1887 the usefulness of these agencies had become so widely recognized that Congress passed the Hatch Act, which provided a small sum for the maintenance of an agricultural station in each state and territory. This year we are celebrating the Fiftieth Anniversary of the passage of that Act and the establishment of the agricultural stations as a national system.

It is interesting to note how your predecessors on the Board dealt with this new opportunity offered by the Hatch Fund. The Station had already developed a strong program in chemistry as applied to the problems of agriculture. The reports for the first twelve years include such matters as the analyses and investigations of fertilizers, soils, forage crops, feeding stuffs, milk, butter, and occasionally such items as condimental cattle foods, Paris green, and salt marsh hay. The testing of seeds was begun in 1880, and especially the Station sought to present in useful form the scientific knowledge of the world as it bore upon the agriculture of the day.

When the Hatch Fund became available, the Station Board carefully considered how it might make the greatest use of this new endowment. Professor William H. Brewer, the secretary, made the following statement in his report:

"It has been a matter of no little solicitude to develop satisfactory plans for the proper expenditure of this addition to the resources of the Station. Various proposals were presented to the Board of Control, and it was decided to establish a new department for the investigation of the fungous diseases of plants, more especially those diseases which affect the crops of this State. The desirability of taking up this line of investigation, with perhaps that of injurious insects, has been frequently discussed by the Board for several years, but the lack of means has heretofore prevented. The National Appropriation now makes it possible, and work has accordingly been undertaken."

The Board was fortunate in securing the services of Dr. Roland Thaxter, then professor of Mycology at Harvard University. Professor Brewer continues: "Doctor Thaxter is now prepared to receive communications on the subject of his department from citizens of the State, who are hereby invited to make inquiries with regard to fungous diseases, including all varieties of rust, smut, mildew, mould, blight, and the like, and to forward to him specimens, concerning which any information may be desired." Thus was established in 1888 the Station Department of Botany under the able leadership of a most distinguished scholar.

The Station and the State suffered a great loss this summer in the death of Dr. George P. Clinton, who for 35 years carried on the tradition of research and scholarship established by Doctor Thaxter at the Station in 1888. At the end of this section will be found a tribute of the staff to Doctor Clinton.

High Points in the Station Year

A disease of tobacco, downy mildew, heretofore unknown in Connecticut but destructive in other tobacco areas, appeared in the State and caused considerable damage. The Tobacco Substation immediately undertook an intensive study and the results at Windsor, as well as a summation of investigations in other places, have been published in Bulletin 405. (See page 315.)

Soil Erosion

Along with the rest of the country, Connecticut has become "erosion conscious". With the Agricultural College, the Station coöperated with the United States Department of Agriculture in making a soil erosion survey of the Scantic River watershed. In our opinion this was an area in which erosion might be most serious. It is the center of the commercial potato industry that has developed recently in Connecticut, and it includes some of the best soils in the State. The survey disclosed a very real erosion problem, and as a result, the Federal Department has set up a demonstration project in this valley. Another erosion survey is now under way, this one dealing with commercial apple orchards in the State. (See page 310.)

Soil Testing

The Universal Soil Testing System, devised at the Station, has been most useful in connection with the AAA program. In 1937, 10,000 soil samples were tested at New Haven, Windsor and Storrs, as a basis for the fertilizer and lime prescribed in contracts with the Government.

Plant Breeding

The new pepper, Windsor-A, developed at the Station, is being well received by our market gardeners throughout the East. It was entered in the competition for All-America Selections of the Seed Trade Association of North America and received a special award of merit.

At the Tobacco Substation a hybrid strain of tobacco that is resistant to mosaic has been developed. While much work remains to be done in perfecting this type, it is a promising resistant Broadleaf tobacco.

Soybean Meal

The Substation has also been comparing soybean oil meal with cottonseed meal as a tobacco fertilizer, and up to the present time it has given excellent results. In 1937 the rating, based on yield and quality, was 24 percent higher than the crop grown with cottonseed meal. The average increase in value for two years was 23 percent. (See page 316.)

New Studies of Mouse Injury in Orchards

The Station is coöperating with the United States Biological Survey, the Connecticut Pomological Society and the Agricultural College, on a study of the pine mouse which has been causing considerable injury in the orchards of the State. Very little is known of the habits and biological cycle of this animal, and a research program is now getting under way.

Increased Measures to Control the Japanese Beetle

The decided increase in Japanese beetles in Connecticut has led to further coöperative experiments and control measures between the Station and the United States Department of Agriculture. Colonies of parasites of both the larvae and adult beetles were reared at the Station and released in several parts of the State during the summer. Checks will be made to determine the value of these in establishing themselves.

Coöperation Between the Station and Growers

Within the State the Station has enjoyed the coöperation and interest of fruit and vegetable growers as well as other groups. The agricultural societies have committees on research which meet each year with members of the Station staff. The research program for the coming season is discussed at these conferences and there is frank interchange of ideas on the problems that need study.

The Staff also has an opportunity to meet and discuss current problems of farmers through speaking engagements which increased in 1937, field days, and groups of persons visiting the Farm and Station. Other

means of direct contact are through constant calls at the Station for advice and information. In one department such calls, by letter and telephone, reached a peak of 70 in a single day last Spring. Experiments are frequently carried out on private property throughout the State, and the staff visits these places in the regular course of its duty. As frequently as possible they also call on persons asking for help and advice on matters about which the Station is informed.

During the Summer the Station held three field days besides the Annual Station Day at the farm at Mount Carmel. One of these was devoted to the breeding and trials of strawberries at Mount Carmel. The others were early and late vegetable days at Windsor.

Staff Changes

Earlier in this section we have mentioned the death of Doctor Clinton. At the time of his retirement from active service as Station Botanist, Mrs. W. W. Kelsey, his secretary for eighteen years, ended her period of service here. In addition to her secretarial duties Mrs. Kelsey was of great help in the department in translating, cataloguing and mounting specimens.

IMMEDIATE NEEDS OF THE STATION

Lack of laboratory and greenhouse space is seriously handicapping the Station work on the breeding of parasites for the control of insect pests, on fruit and vegetable diseases, and the breeding of vegetables. This need has been recognized for several years, but is becoming increasingly acute as our research program progresses. Efforts to secure a small appropriation from the last General Assembly were unsuccessful, as were practically all agricultural proposals. It is hoped that the Federal building grants to the State will make available the small sum needed.

GEORGE PERKINS CLINTON
1867–1937

Dr. George Perkins Clinton died on August 13, 1937.

Graduating from the University of Illinois in 1890, he served there, and at the Experiment Station in that State, for twelve years as Assistant Botanist under Doctor Burrill. He received his doctorate in science at Harvard in 1902, and on July first of the same year he was appointed Botanist at the Connecticut Agricultural Experiment Station. On July 1, 1937, he retired from active service, but remained on the Station Staff in the capacity of Consulting Botanist.

Doctor Clinton's scientific career was largely influenced by Professors Farlow and Thaxter of Harvard, with whom he studied and for whom he held a life-long esteem and admiration that approached reverence. Although he came to be recognized as one of the leading phytopathologists of his time, he preferred, and always retained, the simple title of "botanist", no doubt because that was the title used by his two distinguished teachers.

In approaching research projects his methods were simple and direct. Combining keen powers of observation with ability to draw practical deductions, he often found in nature clues to the solution of his problems by intensive study of circumstances and conditions in the field. He had a wide acquaintance among farmers, many of whose farms were his laboratory.

In consulting and other capacities he served the State Board of Agriculture, later known as the Connecticut Department of Agriculture, the Pomological Society, the Vegetable Growers' Association and the Connecticut Tree Protection Examining Board. Beyond these local interests he was sought for missions that took him far outside the borders of his State, notably in 1908 when Harvard University sent him to Japan to bring to this country parasites for controlling the gypsy moth. As lecturer and research associate at Yale University he especially enjoyed contacts with young men interested in his chosen field of botanical study. In 1935 "Honorary Recognition" as a leader in agriculture and rural life was awarded him by Connecticut State College. His contributions to botanical science were recognized in his election to the National Academy of Sciences in 1930.

Doctor Clinton was fond of travel, and he inherited from his father a hobby for collecting. Thus in his travels at home and abroad he acquired an invaluable collection of botanical specimens, books, reprints and letters in which he took great pride and which are now the property of the Station.

He was possessed of many fine qualities of character that his natural modesty and unassuming manner concealed from all but his more intimate friends. He was sincere, loyal and democratic. Instances of his generosity appear in unexpected places; unobstrusive acts of kindness and sympathy were his habit. As his colleagues of the Station Staff we record the passing of this loyal friend and coworker with deep personal sorrow. His achievements brought lasting credit to the Station which he loved; and his whole career was an admirable example of devotion to the highest ideals of public service.

The Staff of the Agricultural Station.

PROGRESS OF THE STATION'S WORK

ANALYTICAL CHEMISTRY

Each year the Department of Analytical Chemistry makes regular inspections of foods and drugs, feeds and fertilizers, and of miscellaneous other materials. Some of these are official samples collected in accordance with the Statute. Others are submitted by farmers, the Commissioner of Domestic Animals, the Storrs Station, or by private individuals. Results of examinations appear in the annual publications of the department.

Chief items of food and drug inspection for 1937 were carbonated beverages, edible oils, fruits for spray residue, meat products, milk and milk products and tomato products. The total number of samples examined and reported on in Bulletin 401 was 1759. Of these, 1417 were foods, 142 drugs, and 200 were miscellaneous materials. Altogether 73 foods and 67 drugs were adulterated, below standard or questionable. In addition, the department checked 2430 pieces of Babcock glassware for calibration. Most of the samples were submitted by the Dairy and Food Commissioner in connection with the enforcement of the Statutes.

Spray Residue

As interest in residues on fruit is keen, the Commissioner collected 128 official samples of apples from the principal orchards in the State and sent them to this laboratory. About an equal number were examined for growers who submitted samples directly to the Station, and for the Department of Entomology in collaborative studies of solvents for the removal of spray residue. Since it is not economically possible to produce first class fruit without the use of sprays containing lead and arsenic, tolerances must be allowed, and at present, and for several years past, limits of .01 grain of arsenic and .018 grain of lead per pound of fruit have been fixed as adequate to safeguard public health in this matter. Only three samples were found that showed substantial excesses over these limits.

Meat Products

Frankfurt sausage may contain admixtures of cereal products and other starchy materials or skim milk powder. There is no objection to this practice if the additions are declared and the amounts collectively are not in excess of 3.5 percent. Some time has been spent in devising a method for the determination of milk sugar (useful as an index to the probable amount of skim milk powder included) in the presence of dextrose, a sugar sometimes used in the manufacture of frankfurts. A quantitative separation of these two sugars can be made by a procedure based upon the absorptive action of yeast on fermentable sugars. The method is given in detail in the *Food and Drug Report for* 1936, *Bulletin* 401.

Vitamin D Milk

Vitamin D milk is produced by approximately 40 dairies in the State. The value of this food as a prophylactic against infantile rickets has been thoroughly demonstrated, and the State has used a system of checking the

quality since September, 1935. Samples are collected by agents of the Dairy and Food Commissioner and sent to the Station for examination. Using the Station's colony of white rats, bioassays are made and results reported to the Commissioner who takes corrective measures when necessary.

During 1937, the Station made bioassays of 77 samples of Vitamin D milk. Of these 65 contained the unitages of vitamin expected according to the several types marketed; six were on the borderline, and six fell below standard.

Drugs

Of drug preparations not heretofore examined in this laboratory should be mentioned fluid extract of ergot. In 1935 and 1936, 31 samples were examined, of which 20 were substandard. Of these, six were so deficient in the active principles of ergot as to be of little or no value as medicinal agents. Druggists dispensing the preparation do not manufacture it themselves but purchase from pharmaceutical supply houses. Investigation indicated that, as manufactured, the lots sampled were of standard strength, but long standing on the retailers' shelves was the explanation of the deterioration.

Fertilizers

The residual effect of commercial fertilizer mixtures upon soil reaction has been given considerable attention in the last few years. Some mixtures tend to make the soil acid; some are practically neutral in their influence, and others are alkaline. The constant use of acid reacting fertilizers may result in the development of injuriously acid soils. A tentative method for determining this important characteristic has been adopted by the Association of Official Agricultural Chemists and was used in testing about half of the samples of mixed fertilizers in Connecticut during the past year. Thus, in addition to showing how much of each ingredient in a fertilizer formula is guaranteed, and how much is actually present, the chemists mark the sample "A" for acid, "NA" for non-acid and "N" for neutral. Results and explanation are included in Station Bulletin 403.

The bulletin reports on 211 official samples of mixed fertilizers analyzed, representing 627 individual guaranties of plant food elements, and 89 percent of them substantially met or exceeded. Deficiencies were chiefly in the items nitrogen and potash. No evidence of inferior organic ammoniates was found.

Feeding Stuffs

Analyses of 822 official samples of feeding stuffs were made in the inspection for the year 1936. Pasture samples and similar materials for the Storrs Station numbered 323. Fifty-two samples of dog foods were collected and analyzed. These, with miscellaneous other materials, made a total of 1331 for the year. Bulletin 397 includes the analyses and summarizes the results. In all, 2,453 guaranties were made for the official samples and 95 percent were met in all respects.

Dog foods had not previously been included in the annual inspection, but the tremendous increase in the number of brands marketed and the public interest in contents prompted action. In the 52 samples, 119 guaranties

were made, 86 percent of which were substantially met. Although no registrations of dog foods or of vitamin D carriers for feeding livestock are required at present, state regulation is contemplated.

Chicks Used in Feed Tests

A new feature of the regular analysis of feeds for the past nine months has been the use of chicks in biological tests for carriers of vitamin D. On September 1 a regulation was adopted by the Station Director and the Dairy and Food Commissioner requiring the registration of this class of feeding stuffs. It was issued to the trade and the effective date is January 1, 1938. The regulation requires that products offered as vitamin D carriers shall be labelled to show (1) the name of the product; (2) the vitamin D potency of the article in terms of A.O.A.C. chick units per gram; (3) the name and address of the manufacturer or other person responsible for the product; and (4) the net weight or volume of contents of the package.

Insecticides and Fungicides

The statutes concerning the adulteration and misbranding of insecticides and fungicides provide that the Commissioner of Dairy and Foods or the Station may draw samples for analysis. Therefore some attention is given each year to analyses of these and related materials. Violations of the statute are very rare.

A useful compilation of analyses of commercial products of this type was prepared during the year and issued as Bulletin 398. Analyses are mainly those made by this Station or by other Stations, and issued in special or regular bulletins from time to time. None of these was made before 1922. An index lists the products in alphabetical order. This publication revises and enlarges two previous bulletins of the Station, and has been in great demand.

Other Activities

A considerable amount of miscellaneous work not strictly of a regulatory nature falls to the lot of this department. Numerous requests are made by farmers for examination of such products as milk, vinegar, fertilizers, feeds and materials suspected of containing poisons. Many of the latter are specimens of the viscera of farm animals and are often of interest to, or submitted at the suggestion of, the Commissioner on Domestic Animals or the pathologist at the Storrs Station. The work is laborious but it is regarded as important and helpful by those interested.

Members of the staff have served as referees or collaborators of the Association of Official Agricultural Chemists in studies of chemical and biological methods of analysis. The chemist in charge has served as a member of the Committee on Definitions and Standards for Foods of the United States Department of Agriculture and as a member of the Council on Foods and Council on Pharmacy and Chemistry of the American Medical Association. He has served also as chairman of a Committee of the Association of Official Agricultural Chemists to prepare a revision of the chemical section for the seventh edition of "Standard Methods of Milk Analysis", published by the American Public Health Association. He, and members of his staff, have

assisted the Dairy and Food Commissioner and the Director of this Station in revising to date the Rules and Regulations relating to the Food and Drugs Law of this State.

BIOCHEMISTRY

A FUNDAMENTAL interest of the Department of Biochemistry is in the nature of the chemical changes that go on in plant tissues. Station Bulletin 399, recently issued, describes the behavior of organic acids, carbohydrates and many of the nitrogenous components of tobacco leaf tissue when the excised leaves are subjected to culture in water or nutrient solutions in light or in darkness. The chief results of the study of the organic acids and carbohydrates were mentioned in this report last year. The nitrogenous components also underwent profound change. The protein diminished rapidly and there was a corresponding increase in soluble nitrogenous components. Of these, the most important were the amides asparagine and glutamine.

Asparagine alone was rapidly formed during culture in the dark, but both asparagine and glutamine were formed during culture in the light. The evidence suggested that the amino acids produced by the hydrolysis of the protein were deaminized with the production of ammonia. In the dark culture, this combined with a non-nitrogenous substance already present in the tissues to form asparagine. The supply of this normal precursor of asparagine was, however, limited, so that, towards the end of the culture period, ammonia accumulated in significant amounts. On the other hand, in the light, two different non-nitrogenous substances were present which, in the presence of ammonia, gave rise to the formation of glutamine and asparagine. Sufficient of these precursors was apparently available to prevent an accumulation of ammonia during the period studied.

The observations can be interpreted to indicate that a precursor for asparagine is normally present in substantial amounts in tobacco leaf tissue, and accordingly asparagine can be synthesized even in the dark. Under the influence of light, another substance is produced as a result of the reactions of photosynthesis, and this combines with ammonia to form glutamine. Accordingly, both glutamine and asparagine are synthesized under these conditions. Nothing is definitely known regarding the chemical nature of these amide precursors, but it is probable that they are metabolic products of carbohydrates.

The theoretical background of the metabolism of the amides has been examined, and the results of the study of tobacco leaves have been found to conform closely to the views advanced many years ago by Schulze and more recently by Prianischnikow.

Chemistry of Rhubarb

Studies of rhubarb leaves have been carried out along lines similar to the studies of tobacco leaves. The organic acids in particular have been examined, and the distribution of the malic, oxalic, and citric acid in the petioles, main veins, and mesophyll tissue has been ascertained. It has been established that the malic acid of the rhubarb, like that of the tobacco

plant, is exclusively *l*-malic acid. This result is contrary to observations published in Germany some years ago according to which *dl*-malic acid is also present.

The mesophyll tissue of rhubarb is especially rich in oxalic acid which accounts for the toxicity of these leaves when used as greens for human food.

Studies of the amide metabolism of rhubarb leaves have shown that the behavior in water culture in the dark is different from that of tobacco leaves; glutamine alone is produced. In order to be certain of the nature of the chemical changes that occur during culture, the amides of this tissue were isolated by the customary methods. The results showed that the leaves contain large amounts of glutamine but no detectable amount of asparagine. It is therefore evident that the indirect methods used for the determination of amides must be controlled by isolation methods. It appears that plant tissues may in some cases contain substances that seriously interfere with the accuracy of the usual methods of analysis.

Protein Investigations

A redetermination of the basic amino acids of the important maize protein zein has been made. This protein was repeatedly analyzed by Osborne many years ago. The new analysis gave results that agree remarkably closely with the predictions of physical chemists who have studied this protein recently in England and in this country, and have led us to suggest that zein, which has a molecular weight of approximately 35,000, yields four molecules of arginine and two of histidine on hydrolysis. No lysine was detected by Osborne and the new results indicate that none is present.

Beet Pigment

In coöperation with the Department of Genetics, a chemical study has been made of the red pigment of beet roots. The color of the root is of great importance to the farmer inasmuch as the price he receives depends in large part upon the evenness and intensity of the coloration. Pale colored beets are refused by the canning industry and also by other markets.

The color of a given crop is unpredictable, and it is not yet established whether the depth of color is controlled by genetic factors or is a result of environmental conditions during growth. Studies of these points are in progress in the Department of Genetics, but their solution is dependent upon finding a method whereby the color value of any sample of beets can be expressed in quantitative terms.

It seemed that the most useful method would be one that permitted the determination of the actual quantity of pigment present. Accordingly attempts were made to isolate this substance in pure form. Beet roots were dried and extracted with neutral alcohol, whereby yellow pigments, sugars, and soluble nitrogenous substances were removed. The powdered material was then extracted with acidified alcohol whereby the red pigment was brought into solution. Neutralization of this extract with lithium hydroxide yielded a precipitate that contained most of the pigment. Purification

was effected by precipitation with lead acetate and subsequent crystallization from water, or by precipitation from alcohol solution with ether. The final product was a partially crystalline, intensely colored solid with a greenish metallic luster, analysis of which suggested that the pure substance has the chemical formula $C_{15}H_{13}N_2O_5Cl.C_6H_{10}O_5.3H_2O$. It was shown to be a glucoside of a pigment nucleus that is probably of the anthocyanidin type, but which differs from the anthocyanidins responsible for the color of the grape and of most flowers and fruits in that it contains nitrogen. Although nitrogenous pigments of other types are known in nature, only one other nitrogenous anthocyanidin has been definitely recognized, that of bougainvillaea petals. This substance contains one atom of nitrogen per molecule. The beet pigment is therefore unique in that it is the most highly nitrogenous pigment of its type that has been found.

The form of linkage of the nitrogen in this substance is as yet unknown. It is definitely not combined in an amino acid-like type of union as is held by English investigators, and the most likely hypothesis is that it is present in some form of ring combination.

The physical properties of the purified pigment were examined and a simple method was found to determine the quantity present in a sample of the root. The method depends upon the specific absorption of this substance for light of a wave length that corresponds to a green color. By measuring the quantity of green light absorbed by a dilute solution of the pigment, the quantity of pigment in the solution can be calculated, and referred to the amount of beet root tissue used in preparing the solution. This method is being employed by the Department of Genetics to study the agricultural problems involved in the growing of beets. The purely chemical problem presented by the structure of this important substance is being further investigated.

Nutrition Investigations

One phase of the study of the inorganic salt requirements of the rapidly growing rats of the Experiment Station colony has been completed, and two papers have appeared during the year. The new salt mixture that has been devised is better adapted to the needs of these animals than the formerly used Osborne and Mendel salts, and these studies have made it possible to ascertain with some exactness the daily calcium and phosphorus needs of the young growing animal. This work is being continued with special emphasis on the calcium and phosphorus requirements per unit of body weight for different periods in the growth of the rat.

An investigation that was started some years ago by Professor Mendel in collaboration with Dr. E. A. Park, of the Johns Hopkins University, has been extended. The work dealt with the matter of the optimal calcium to phosphorus ratio in the diet of the albino rat, and grew out of an attempt to develop diets of purified foods for the study of rickets. Some of the earlier experiments were not wholly successful because growth was unsatisfactory when a diet of purified foods was used. With an edestin diet essentially the same as the original one, but containing double the supply of yeast, the rate of growth was much improved. These experiments showed that a ratio of calcium to phosphorus of 1:1 gave the most satisfactory results as judged by rate of gain in weight and by the percentage of

ash in the bones. This was true with each of three different rates of calcium intake.

The extensive investigation of reproduction of the albino rat, carried out for several years in our laboratory under the supervision of Professors Arthur H. Smith and William E. Anderson, formerly of Yale University, was continued through seven generations before the experiment was terminated. The purpose of this investigation was to study the influence of the interval between matings upon the reproductive performance of the albino rat. This work has been summarized for publication and indicates that, for the animals of this colony, under the customary dietary conditions, it is possible to obtain reproductive success with intervals of one, two, or three weeks between weaning a litter and subsequent remating. There was a slight superiority in the performance of those animals permitted a rest of two weeks, as judged by the criteria used, namely, percentage fertility, number of young born, number weaned, and weights of the young at weaning.

BOTANY

The Botanical Department received more requests than usual for information and advice on a wide range of botanical and horticultural subjects during 1937. Before Doctor Clinton retired, he arranged specimens which are now on display in the cases in the hall and in the library. Collections of letters and photographs of famous botanists from many parts of the United States and of the world were framed or filed in the library. During the summer collecting of specimens continued and these were identified and given a place in the herbarium with approximately 100,000 other specimens. About 25 types of woody fungi growing on trees not formerly represented in the Station collection were donated by Mr. Hilborn of the Maine Station.

Late Blight on Tomatoes

One of Doctor Clinton's chief interests was the investigation of the late blight of potato, *Phytophthora infestans*, the disease that is said to have been chiefly responsible for the great Irish famine in the Nineteenth century and that is still one of the most serious threats to the potato crop. It was Doctor Clinton who first produced in culture the oospores or mature stages of the fungus causing the disease. Of late years the same disease has seriously injured the tomato crop. The source of the infection is not established.

Doctor Clinton spent much time on this problem, finally coming to the conclusion that the disease appeared on tomatoes only when they were growing near potatoes on which the blight had appeared earlier in the season. It was this research that was to have been the object of his studies after retirement on July 1, 1937. And it was his ardor to push ahead his research that was the cause of his death on August 13.

One case of blight was found early in the season, and on one of the warmest days of the summer Doctor Clinton visited more than 17 fields looking for further infection. Immediately afterward he was taken ill.

Reporting on the findings for 1937 his assistant states: The first sign of blight appeared in a potato field on June 30 in Guilford. A tomato field stood next and in order to protect the tomatoes, the potatoes were completely destroyed. Tomatoes in neighboring patches were examined at 10-day intervals until frost, but no blight was found.

Potato foliage at Windsor showed disease on August 31 and nearby tomato fields were left unprotected. As a result, the blight appeared on green tomato fruits in places nearest the potato vines on September 30. Lighter infections were noticed in other places, but it was so late in the season that there was small loss.

From observations during the past few years, indications are that it is safer not to plant late maturing tomatoes near late maturing potatoes.

Since the intensive culture of vegetable crops on a large scale is a relatively recent agricultural development, many details of disease control are as yet in the empirical stage. It is the purpose of scientific research to modify existing methods to meet the particular conditions at hand and, if necessary, to develop new controls that will enable the grower to obtain profitable yields from his crops. The Stations's work attempts to determine the control measures best suited for Connecticut conditions and to discover any new ones that may prove more effective and less expensive.

X Disease of Peach

X disease of peach continued to be a major field of disease study in 1937. This problem, that appears to be unique to Connecticut peach orchards, seemed near solution last year. In the 1937 season, however, progress was retarded and findings in the four lines of investigation were mainly on the negative side.

The peach budding experiment, in which healthy trees were budded with diseased buds in order to determine the nature of the trouble, was ruined by accident. Copper spray from the apple spraying experiment drifted to the peach trees and injured them so badly that it was not possible to determine the presence of X disease definitely. However, a new supply of diseased buds was grafted into stock grown in sand culture this season. Root and top grafting were also tried, and results will be available in 1938.

In an effort to determine whether insects carry the infection, small peach trees were placed in the vicinity of diseased choke cherries at two-week intervals during the season. Others were kept under cheese cloth cages in the same locality as checks. Observations will be made in 1938.

Again no results were obtained from fertilizing diseased trees in a commercial orchard with varying amounts of zinc sulfate and of lime. These materials were applied to the soil in April and June in amounts of from 3 to 10 pounds per tree for zinc sulfate and 5 to 20 pounds for lime. A few trees were fed a combination of both materials with no visible effect.

Observations this season indicate that apparently it is not practical to cut out diseased branches in an effort to check the progress of the disease. Trees so treated showed that in many cases the disease reappeared even after a healthy period of several months. Reinfection could have accounted for some of these cases but it appears to be wise to discontinue this method of control until we have further knowledge.

The removal of choke cherry around several orchards in 1936 did not give any positive data except to show that apparently the operation was too late. Infection of the peaches had already taken place. Most of the new cases were discovered early in the season and there was not the usual spread later. Further work along this line was started in 1937 in an attempt to correct some of the errors of 1936.

Survey work showed diseased choke cherry to be present over a much larger area than before and diseased peaches were found in some orchards outside the original areas. These cases were predicted in 1936 from the presence of diseased cherry. In most places the owners removed the diseased peaches and killed the choke cherry immediately with a fair probability of checking or controlling the disease.

Apple Spraying

For many years the departments of Botany and Entomology have coöperated in an apple spraying program to control insect and disease pests. The following materials were used in 1937 at the Station farm at Mount Carmel: Lead arsenate, lime and fish oil; lead arsenate, lime and basic copper sulfate; lead arsenate, dry lime sulfur and catalytic sulfur; and lead arsenate and Dritomic sulfur. Bordeaux mixture was used on the basic copper sulfate plots in the pre-pink and pink sprays.

The orchard contains several varieties, and all trees received the pink, calyx, seven-day, fourteen-day, and twenty-five day spray, and one treatment in July. A pre-pink spray was applied on McIntosh only. The mixture containing copper sulfate injured McIntosh and was discontinued, but was used on other varieties.

As in previous trials, the lead arsenate-lime-fish oil gave a high percentage of perfect fruit, except on varieties susceptible to apple scab, such as Fall Pippin. Several growers tried this mixture successfully, and as their experiment was watched carefully by other growers it will probably have more widespread use in 1938.

McIntosh is also susceptible to scab but the Dritomic sulfur mixture gave fruit that was fully as clean as that sprayed with dry lime sulfur and catalytic sulfur.

No definite data resulted from the special cedar rust spray with commercial lime sulfur on Wealthys at Mount Carmel, as little of the disease was present. A semi-coöperative experiment in Southington showed good control.

Sand Culture of Seedlings and Young Plants

Following the earlier demonstrations of the effectiveness and practicability of sand cultures in producing seedlings that are free from the usual losses caused by damping-off, further experiments have been made to improve and simplify the method. It has been found possible to use fairly clean sand just as it comes from the sand-pit or dealer without washing in hot water, as previously recommended. The hot-water washing is advisable as an extra precaution if only a small amount of sand is required or if very expensive seeds are being planted.

Improvements have been made in the watering of sand cultures to prevent carrying the fertilizers away and to insure a constant moisture supply. Small cultures such as glazed crocks, metal containers, or wooden flats are provided with a few small holes in the bottom and allowed to stand in a shallow tray of water. Benches of sand, for growing seedlings or young plants up to a size suitable for transplanting in the field, have been successfully watered by means of a perforated garden hose attached to a vessel containing water and lying along the center of the bench on top of the sand.

Feeding of the cultures is done once or twice a week, or even less frequently, by sprinkling the sand with a solution containing one teaspoonful each of saltpeter, superphosphate, and epsom salts to a gallon of water. Earlier recommendations calling for only saltpeter as a fertilizer have been found to apply best to used sand that has had phosphorus added in previous cultures. New sand should be fertilized with superphosphate in addition to saltpeter. Complete chemical fertilizers of almost any common formula, used at a rate of about three or four teaspoonfuls to a gallon of water, have been found to provide for excellent growth of seedlings and young plants in sand. In the case of rapidly-growing seedlings that are apt to have too long stems, it has been found possible to produce stocky plants, even in fairly dense stands, by withholding the fertilizer until after the seedlings have been up for several days.

Sweet Potato Diseases

Certified plants obtained from other states yielded larger percentages of healthy sweet potatoes than uncertified plants from these sources and also more than sprouts raised from commercial sweet potatoes. The latter two groups of "seed" plants showed higher incidences of disease, especially stem rot, black rot and scurf.

Slip-seeding was again successfully accomplished in 1937 at Mount Carmel for the third consecutive year. A yield of about one bushel of disease-free slip-seed from each 100 slips (planted July 12, taken from plants set on May 26) was obtained from slip-plants that were killed by frost on October 8. The special problem of fertilizing sweet potatoes in Connecticut is discussed under Soils, page 311.

Cabbage Yellows

Cabbage was planted at Mount Carmel in the same plots as in 1936 and a larger percentage of plants than last year was afflicted by yellows. This disease is caused by a soil-borne fungus, *Fusarium conglutinans*, and results indicate the importance of crop rotation to prevent epidemics arising from increased inoculum in the soil. Yields of cabbage varieties resistant to yellows again were comparable to those of non-infected plants of native susceptible strains.

Stewart's Wilt of Sweet Corn

Following the mild winter of 1936-37, bacterial wilt of corn was again found in the southern part of Connecticut after a period of three wilt-free seasons. On some varieties, infection amounted to as much as 25 percent of the plants by the last of June. Since many growers had planted hybrid

corn that was resistant to bacterial wilt, the disease did not cause widespread loss.

A New Pepper Disease

A wilt disease of peppers was found in Connecticut for the first time in 1937. Examination of the wilted plants showed the presence of a fungus in the vessels of the lower portion of the stem. Cultures of the fungus resulted in each case in the growth of a species of *Verticillium.*

Spraying Experiments with Muskmelons

Melon blight, or downy mildew, is a disease that occurs often enough in Connecticut to make the cultivation of melons a precarious business. Some kind of spray is necessary and Bordeaux mixture frequently injures melon foliage. In an effort to find a substitute that is easier to handle and does not injure the plants, several other copper sprays were tried at the farm at Mount Carmel.

The results of both the 1936 and 1937 seasons indicate that certain of these Bordeaux substitutes may be much more desirable from a standpoint of convenience of use and plant-injury effects than Bordeaux itself. Results of 1937 seem to show that they also offer ample protection against muskmelon mildew blight.

Potato Spraying

The past season was the seventh consecutive year of experiments in spraying Green Mountain potatoes at Mount Carmel with different strengths of Bordeaux mixture.

As usual, marked increases were again obtained from spraying, varying from 95 to 134 percent of the yield from unsprayed plots. As in 1936, however, the difference between the various concentrations of Bordeaux was not significant: Unsprayed, 200; 4-4-50, 464; 6-6-50, 467; 8-8-50, 463 bushels per acre. For the seven years' work the average is as follows: Unsprayed, 147; 4-4-50, 254; 8-8-50, 289 bushels per acre. It would seem, therefore, during a late-blight-free year and when growing conditions are very favorable, as in 1937, that the advantage from using a concentrated Bordeaux mixture on potatoes may not be so great as during seasons when the crop is struggling against drought.

During the past season at Mount Carmel, potatoes sprayed six times, beginning on July 1, yielded fully as well as similar plots sprayed eight times, beginning on June 18. Those sprayed five times, commencing July 14, gave high yields, 389 bushels per acre, but this figure was definitely lower than those obtained with the six-spray schedule started exactly two weeks earlier. These results are somewhat similar to those of 1936 when an increase of only 23 bushels per acre was obtained by applying the first spray on June 11 rather than on July 2. But the potato plants died prematurely from drought in August in 1936, which would possibly tend to exaggerate the value of the early spray applications.

Plots of Irish Cobbler potatoes sprayed twice, and others four times, with 6-6-50 Bordeaux mixture, all gave yields varying from 35 to 40 percent larger than unsprayed plots of this variety.

During the favorable growing season of 1937, the yields obtained from unsprayed plants of the blight-resistant potato (No. 44-488 U.S.D.A.) were almost identically the same as those from unsprayed Green Mountain plants. In previous dry years this resistant variety gave much higher yields than the Green Mountains. Similar yield increases were obtained from both varieties when sprayed with Bordeaux mixture.

Chestnut Blight

Throughout the State, many chestnut sprouts are found and some even bear nuts in favorable seasons, but practically none is free from blight. It is possible that the organism will gradually lose its virulence. To test this possibility, the Station Botanist planted seedlings in several parts of the State. In the past year a check-up on all of these plots yielded the following data:

C. M. Taintor estate	Southport	75 trees found	1	infection
Racebrook	Orange	130 " "	5	"
Portland Forest	Portland	200 " "	19	"
Rainbow	Windsor	350 " "	0	"
Station grounds	New Haven	100 seedlings	0	"
Mt. Carmel	Hamden	100 (estimate)		

In comparing the plot sites the following descriptions apply: The Southport planting is under large trees in a used pasture land; at Racebrook the planting is along the edge of a rather dry woods; at Portland the planting is in a wooded area; at Windsor the planting is in a semi-open area; at Hamden the trees are set mainly along a stone wall in the open. The Station seedlings are still in the close formation of a seedbed.

The blight has been found in all the plots at one time or another, but it has been less common at Rainbow where the generally drier conditions probably have not favored its growth. No attempt has been made to correlate the amount of infection occurring in the plots with a similar area outside.

On the whole the trees planted in the wooded areas have not grown very tall as the competition is keener and the conditions apparently poorer than they are in more open spaces. Outside the woods growth has not been uniform, some trees remaining 15-20 inches tall and others reaching a height of 8 or 10 feet. Application of some fertilizer around the trees at Rainbow, at Mount Carmel, and at Racebrook resulted in better growth.

Doctor Clinton's records of the exact percentage of chestnut blight infection which has occurred in each plot have not been located. The writer has observed during the last seven or eight years that none of the plantings has had any wholesale infection—probably in no case as high even as 25 percent of the original number of trees set out. On the other hand the combined losses from drought, winter injury, insects, competition and some mechanical damages have resulted in a 50 percent or even higher loss of trees originally planted. Some attempt to adjust these losses has been made by replanting with young trees, but there were not enough trees available for complete filling-in. Each plot now contains chestnuts of various ages.

Finally, these plots are well defined and the trees well established so that by making counts it would now be possible for several years to determine the rate at which new infection was occurring in these areas.

At Lebanon the oldest surviving chestnut is very close to death from blight and severe winter weather.

The Genetics Department has been raising some Oriental chestnuts at the Station Farm and these appear to be disease resistant. They gave a good crop of nuts in 1937.

Dutch Elm Disease

During the past winter further work was done on *Ceratostomella ulmi* with the hope of solving an unusual situation in the perithecium. Crossings made of successive one-spore cultures of the two strains to the tenth generation still show the body, and this indicates that it is not due to a contamination. Since it is found with all the various killing agents used, it cannot be an artifact. Two new cultures of the fungus have now been received from Holland and perithecia produced from them may show something of interest.

During the year 421 cultures of elms were made, mostly in summer from specimens obtained by the Station scouts. Of them 244 developed Cephalosporium and 15 gave Verticillium. Seven cultures produced *Graphium ulmi* but these were verifications of results obtained by the federal laboratory at Morristown and no new infection was discovered by the Station scouts. The remaining cultures were indefinite or sterile. The number of specimens of diseased elms submitted by the scouts is a very small percentage of the trees inspected, indicating that the general condition of elms in the State is good.

Maple Wilt

Since no survey of Verticillium wilt of maple has been made, it is not certain whether the increasing number of cases reported indicates increase in the disease or greater public concern for trees. The number of specimens voluntarily brought into the laboratory has been slightly larger each year. The method by which infection occurs is not fully known. No doubt it can take place through the roots but in many cases individual branches show infection which does not extend to the base of the tree. Therefore there must be a means of entrance into the tree other than through the roots, and this is a problem which needs some consideration. It may be through the leaves, buds, young twigs or wounds.

That Verticillium can live over in the soil has been demonstrated on the grounds of this Station. For three successive years the disease has been isolated from coleus planted in the bed nearest the "barn". There is no clue as to how the bed became infected. Coleus is a new host for this fungus and was first mentioned in the Report for 1936.

Chrysanthemums (Nematodes)

Nematode injury to chrysanthemums at Bristol continued to interest the Botanist in 1937. Nicotine and Bordeaux sprays in the greenhouse and

the field appeared to control the trouble in 1936. However, there was only partial control during the past season and the treatments caused some injury to the plants. The expense of spraying is also high. Plans are being made to investigate other possible methods in the coming season.

Seed Testing

The testing of seed for germination and purity is a growing project of the Botanical Department. In 1937 more samples were handled than ever before and the work promises to increase with the ruling requiring statement of germination percentage on vegetable seed offered for sale in Connecticut. Samples are collected by agents of the Commissioner of Agriculture and sent to the Station for testing. Official samples of agricultural seed analyzed at the Station numbered 244 this year. In addition 186 samples from other sources were tested.

ENTOMOLOGY

Two gifts containing more than 500 specimens and several thousand additional insects captured by members of the department staff increased the Station insect collection in 1937. A lot of 236 insects representing 14 species of Cynipidae and Chalcididae of the Order Hymenoptera, all reared from plant galls, was presented by the Bartlett Tree Research Laboratories at Stamford. Nine of these species were new to our collection. Other welcome additions were presented by Mr. Harry L. Johnson of South Meriden in a miscellaneous lot of about 311 specimens. In all, the Station collection contains well over 100,000 insects which are mounted in cases in the entomological library.

Elimination of the Mosquito Nuisance

Since 1915, when the General Assembly passed the mosquito control act, the Station has carried on the work required by this statute. Prior to, and since that time, surveys of mosquito population and breeding places have been made in many parts of the State. The control activities have been confined largely to the salt marshes in which breed those species that can fly long distances in search of food. This migratory habit makes the control of the salt marsh mosquito a regional rather than a local problem and logically requires the intervention of the State. Now that the Connecticut shore is a highly developed residential and recreational area from Greenwich to Stonington, the salt marsh mosquito problem is of greater economic importance.

The Connecticut salt marshes have had a most interesting history. The first settlers found the country almost solidly wooded and no forage for live stock was available, except in the salt marshes along the shore and the narrow meadows along the larger streams. Therefore these marshes were highly prized and divided into small plots so that there were many individual holdings. In some of the Connecticut river towns the farms ran from the upland to the river in long narrow strips so that each farm included a portion of natural grassland.

The improvement of these meadows by ditching, diking and tide-gating, began very early. To facilitate mowing and to improve the quality and

yield of the hay, depressions were filled and the marshes made quite smooth. Tide-gate and meadow associations and companies were chartered by the Colonial Assembly, some of which are still in existence. With the clearing of the upland, and the introduction of cultivated forage plants, the meadows lost some of their importance. However, as late as 1915, large quantities of salt hay were made, some of which was sold for packing crockery.

The rapid residential and recreational development of the shore has changed the situation materially. However, a considerable quantity of salt hay is still cut by farmers along the shore, and some of this is used for mulching strawberries.

The Station entomologists began the study of the mosquito problem as early as 1903. In 1904, the entire area of salt marsh was surveyed and mapped. Many other surveys have been made and the information furnished to the towns interested. The first ditching for the control of the mosquito nuisance was done in the salt marshes of Stamford in 1911 with funds raised by local people. Up to 1933 some 12,000 acres, or about half of the salt marsh, had been drained or partially drained. All of this capital outlay was at town or private expense, but beginning in 1915, when the statute was passed, the task of supervision was laid upon the Station. Recognizing the necessity for keeping the drainage systems in operating condition, the State has made a small appropriation each year for maintenance. This task also has been assigned to the Station.

The 12,000 acres above referred to were not contiguous but scattered, with the result that many communities and shore residents were greatly annoyed by mosquitoes flying in from towns that had not been drained. A striking example of this was found in New Haven which had drained all of its salt marsh by 1917. However, the towns to the north and east were not drained, and the many broods of mosquitoes emerging in these adjacent areas made life miserable in New Haven throughout the summer. Another illustration is at Hammonasset State Park which was well drained, but into which mosquitoes flew from other marshes.

The inauguration of the Federal Relief program offered an ideal opportunity to complete the work along the entire shore. The towns contributed transportation, tools and materials, and the Federal Government paid for the labor. The Station was assigned the task of supervising this large project. At times as many as 2,000 men were at work. Although the efficiency was not so great as under the old contract system, the results have been remarkably good and practically the entire area is now drained. Another objective of this program has been to put all of the marshes already drained into excellent condition, particularly through the installation of permanent tide gates, dikes and outlets. Ditches have been cut into the pools that formerly did not drain, particularly in the backs of the marshes, which are apt to be low. In all of this new work, provision is being made to regulate the height of the water so that the ditches may be drained for cleaning and the quality of hay will be satisfactory, but at the same time the mosquito breeding may be kept at a minimum.

During the past year an average of 700 men has been available, and although progress is slow, the results are very satisfactory.

The Relief program also made possible work in several inland towns. This has consisted chiefly of cleaning and straightening polluted streams

within urban areas where fresh water mosquitoes have been a great nuisance. The health aspect of this fresh water work is important since we have Anopheles, or malarial mosquitoes, in this State, and outbreaks of malaria are only dependent on the presence of an individual who is a carrier.

Carpenter Ants in Telephone Poles Controlled

The life of wooden poles used in Connecticut is seriously curtailed by carpenter ants that commonly infest them. Control of these ant colonies by means of injections of poison into the cavities has proved feasible in experiments carried on over a period of four years in coöperation with the Southern New England Telephone Company. Station bulletin 403 gives the results in full.

About two-thirds, or 200,000, of the telephone company poles are chestnut and 70 of these were used in the experiments. Each year the company is forced to replace a percentage of poles because they are unsound, and 10 percent of the rejections are caused by ant injury. The object of the investigation was to find a way of destroying the ants and preserving the valuable poles.

The bulletin states that ants do not discriminate between poles whose butts have been treated with creosote and others. They do not eat the wood, as termites do, but excavate to make a home for the colony. The cavities examined ranged from two to ten feet in length. Parts of the poles had been completely hollowed out and in other parts the wood was honeycombed with vertical galleries. Winged adults, which appear only when a colony has reached its peak, were present in every case.

Many kinds of repellents and insecticides were tried out in the course of the work. The successful method was to sound out a pole for the top of the ant cavity, to bore a hole at this point, insert a metal tube attached to a gun and forcibly inject the poison. By use of a suitable chemical in proper amounts ant colonies can be eliminated. In the telephone company experiments, coal tar creosote diluted with an equal volume of either "refined" creosote or gasoline was efficient. Besides the insecticidal qualities of creosote and gasoline, both undoubtedly possess repellent and fumigant properties. Not less than one pint of material should be used in a cavity up to four feet in length, and not less than a quart in those between four and seven feet. Poles with cavities extending more than seven feet above ground are probably not worth treating. Success depends upon the skill of the operator.

Whether ants will reinfest treated poles has not been determined although there have been no instances so far. Chestnut poles only were used in these experiments.

Termite Control

Complaints of termites infesting buildings have continued to come to the Station in increasing numbers in the past year.

During 1936, ninety-six buildings in Connecticut were examined at the request of the owners who suspected infestations. There were no termites in seven, but anobiid beetles were causing trouble in four, carpenter ants

in 2, and Buprestid borers in one. The examination of three building sites discovered heavy infestations in each and metal termite shields were suggested for proposed houses.

Checking on the permanence of methods used to curb termites in eight buildings, the following data were collected: Termites were found in the timber of these buildings treated by a commercial chemical control concern, in one partially shielded building, and in one shielded dwelling in which specifications for clearance in unexcavated areas were not followed. One completely shielded house, and another in which all wood was removed from contact with the ground and a soil treatment applied, showed no signs of termites.

Continued investigations of the behavior of termites in infested buildings following installation of metal termite shields have shown that, if the sills or other large timbers are wet, the termites will make every effort to make a new contact with the ground. Specifications for protecting a house with termite shields must be followed strictly if they are to succeed. It is necessary to inspect newly shielded buildings at monthly intervals during the first year to destroy any hanging shelter tubes. This procedure has been suggested in Bulletin 382, which is a study of the situation in Connecticut with recommendations for control.

Control of the Japanese Beetle

The Japanese beetle, that has caused so much havoc in the lawns, orchards and gardens of New Jersey, is definitely increasing in Connecticut. In 1937 traps set in places where none of the pests had been found previously, caught beetles in nine towns: Clinton 1, Durham 2, Guilford 7, Lakeville 12, Madison 43, Norfolk 1, Southington 2, Stafford Springs 3, and Thompsonville 19.

At the same time the number of beetles in the old centers of infestation and in the shore towns west of and including Branford multiplied. They are now most abundant in Bridgeport, Branford, Hartford, New London, New Haven, Greenwich and Ridgefield. A heavy infestation occurred in the East Hartford meadows. In Bridgeport they were feeding on linden, elm, Schwedleri maple, white birch, willow, mountain ash, plum, cherry and sassafras trees. There was also general feeding on grapevines, roses, hollyhocks, Virginia creeper, evening primrose and other host plants in towns and cities where beetles were abundant.

In the report for 1936, it was mentioned that the elm trees in Riverside Park, Hartford, were damaged by feeding and the lawn area was treated with arsenate of lead. As a result, there was little or no feeding on the elms this year. However, many beetles fed upon the native evening primrose.

With the larger population of beetles comes a corresponding increase in grubs that are beginning to damage turf. An investigation made at the request of the Greenwich Park Department revealed that approximately 10 acres of turf were damaged by the combined feeding of the Japanese beetle, Asiatic garden beetle, *Autoserica castanea*, and a native insect, *Ochrosidia villosa*. The town appropriated $2,500 for the purchase of arsenate of lead and its application. Twice that amount has been included in the town budget for the fiscal year 1938 for the same purpose. More

than 12 acres of turf were treated in Bruce, Binney and Byram Parks during the fall.

The nursery and greenhouse firms classified under the Japanese beetle quarantine regulations were scouted and inspected during the year for possible infestations. In January there were 100 classified nursery and greenhouse firms. Later 14 were dropped from the classified list by request or were found infested with the Japanese beetle. Nursery and greenhouse stock, as well as farm products, were inspected for shipment and 51,584 certificates issued, while 167 certificates were issued for sand, soil and manure.

Experiments with parasites to check the increase and spread of the beetle are part of the coöperative control between the Station and the U. S. Department of Agriculture. Last year three colonies of 100 females each of *Tiphia vernalis* were released in Bridgeport and one in New Haven. Recoveries of the parasites were made in 1937 from one colony in Bridgeport and the one in New Haven.

During the past season five more colonies were released, two in Ridgefield and one each in New Haven, Branford and New London. Later in the season five colonies of *Tiphia popilliavora*, another parasite of the Japanese beetle larvae, were also released. Three of these were in Bridgeport and one each in Branford and East Hartford. Also about 600 females of *Centeter cinerea*, a parasite of the adult beetle, were liberated in Hartford. All were placed in areas where there was an abundance of beetles or grubs.

Dormant Sprays for the Control of Pine Leaf Scale

Pine leaf scale on ornamental pines has become a major pest in nurseries and ornamental plantings around homes in the past two seasons. Formerly the recommended treatment for this pest was two summer sprays of nicotine sulfate just after the eggs had hatched. When the waxy scale has formed over the insects a few hours later, this treatment is of doubtful value and the exact timing is thus a difficult matter for most persons.

Little has been known about the effect of dormant sprays. For this reason the Station tried several to kill the insects and eggs during the dormant season. Thirteen different materials were applied October 21, 1936, on mugho pines. Eleven of these were commercial oil preparations and one each of 5 percent kerosene emulsion and liquid lime sulfur, one to ten. When examinations were made on December 15, many eggs were dead on most of the plots but the largest kill was obtained by the kerosene emulsion and liquid lime sulfur.

The tests were repeated again on April 30, 1937, on different plants. At that time the mugho pines had made some growth. Upon examination it was found that each of the oil sprays had killed many eggs but that lime sulfur had killed practically all of them. Later examinations during the summer and fall showed that some new scales were present on all plots except the lime sulfur sprayed trees. Lime sulfur was used at the dormant strength, one gallon liquid lime sulfur to 9 gallons of water.

The Oriental Fruit Moth

Parasite and dust experiments for control of the Oriental fruit moth, one of the seven most destructive pests of fruit in Connecticut, were continued in 1937.

Besides the usual rearing and distribution of parasites, an extensive study of egg and larval parasites was made under field conditions in many commercial orchards. The results resembled those previously recorded: Where total parasitism is high during July, the infestation at harvest is low.

The largest number of larval parasites ever reared here, 7,000,000 Trichogramma, were distributed to growers through coöperation with the Connecticut Pomological Society. Other liberations of parasites were: 27,380 *Bassus diversus*, 20,308 *Macrocentrus ancylivorus*, 6,137 *Dioctes molestae*, 391 *Orgilus longiceps*, and 7,673 *Phaeogenes haeussleri*. All except Macrocentrus were imported parasites received through the United States Department of Agriculture and multiplied in our laboratories.

In the experiments with insecticides, derris and fixed nicotine were used on a block of Elberta peach trees laid out in Latin square arrangement. Results showed no improvement over the untreated plots.

European Pine Shoot Moth

Work on the European pine shoot moth followed lines both of research and control during the past year.

Continuing the study of the biology of this serious enemy of red, mugho and Scotch pines, observations were made on the relation between the amount of sunlight to mating and oviposition. These functions occur between 7:30 and 9:30 p.m. in June and early July. Light on the north, south, east and west was measured and there seemed to be no correlation between this and the position of population on the trees. Also there is no indication that larvae move very great distances, from twig to twig, for instance. These habits have a bearing on the density of planting red pine to the subsequent shoot moth injury.

The population trend is being followed in two stands of red pine, one about 8 to 10 feet in height where the insect is increasing in numbers, and one about 25 feet in height where there is a decrease. The relation between height of trees and shoot moth population is significant in regard to injury the insect may do and the successful raising of red pine. Several females were dissected to determine the egg potential, and the population and number of eggs actually laid. The data show a remarkably low number of eggs per female. It is doubtful if they lay 10 percent of the theoretical number based on examination of the ovaries.

Further studies are being carried on to determine the relation between climate, particularly temperature, and the hibernation of the larvae.

In the field of control, some data have been collected on the parasitism of the shoot moth. The native wasp, *Hyssopus thymus*, is quite common and apparently can maintain itself on the shoot moth alone. It is gregarious and has several generations a year. Another larval parasite, *Orgilus obscurator*, has been established in some red pine stands by the

U. S. Bureau of Entomology and Plant Quarantine. In a Branford stand the parasitism was 20 percent in the spring of 1937.

Continuation of the experiment in control by use of insecticides has resulted in working out a good spray schedule with at most two applications of ground derris or cubé with a suitable spreading and adhesive agent. This material is much superior to lead arsenate, with fish oil as an adhesive agent, when the latter is used at the rate of 3 pounds per 100 gallons as compared with cubé or derris at 4 pounds per 100 gallons. A modification of the technique of spraying may make this method of control economically feasible in forest plantings.

The annual examination of red pine stands in northern Connecticut has placed the control of the shoot moth by the Civilian Conservation Corps crews on a more efficient basis. Control operations are now carried out only in those stands where the insect population is dangerously high. Four factors enter into the determination of what constitutes danger. They are: low temperatures of the locality in winter, the density of the insect population, the rate of growth, and the height of the trees. The relation between these and shoot moth outbreaks has been worked out for Connecticut conditions.

White Pine Weevil

In coöperation with the U. S. Department of Agriculture, the Station continues the long time project aiming to discover the relation of rate of growth and pruning methods to the recovery of white pine from weevil attack. The pine stands under observation are in the Eli Whitney Forest near New Haven, the Station forest at Rainbow and the Yale Forest at Keene, New Hampshire. These widely separated locations provide a variety of soil types on which white pine is grown, as well as a range in weevil abundance.

The Biology and Control of the White Apple Leafhopper

The white apple leafhopper is a perennial pest of Connecticut apple orchards. Two lines of control were tried in 1937: (1) Early spray applications in May, using three-fourths pint of nicotine sulfate to 100 gallons of water at calyx; (2) Treatments in September, consisting of (a) half strength nicotine sulfate, (b) full strength nicotine sulfate, and (c) a commercial pyrethrum spray.

Results at harvest indicated that early application was not sufficient to prevent spotting in September. They also indicated that half strength nicotine, early in September, did not give the desired protection on Greening, but was satisfactory on Baldwin. Full strength nicotine sulfate applied to the under surface of the leaves about September 1 gave complete protection even where the nymphs averaged five to six per leaf. Commercial pyrethrum did not live up to its high recommendation in killing nymphs. Apparently it gave fair protection, however, since fruit spotting was less than with other controls except full strength nicotine sulfate at the rate of one pint to 100 gallons.

Predators of the European Red Mite

Considerable time has been spent in following the different enemies of the European red mite throughout the season and determining the effect

of various spray treatments on them. Three of the most important have been located during the winter on the bark of apple trees and have been observed in relation to dormant sprays as well as summer applications. In the case of summer sprays, sulfur is probably the principal agent in killing some of the most important predators, mites of the genus Seius. Summer oil, lime, lead arsenate, nicotine and pyrethrum sprays have relatively little effect.

European Corn Borer

Trials of sprays devised by the U. S. Department of Agriculture for control of the European corn borer in Connecticut were again successful. One spray contained pure ground cubé root at the rate of 2 pounds in 50 gallons of water, with and without spreaders. It was applied four times, on June 9, 15, 22 and 26, for the first generation, and 75 percent of the ears were borer-free as a result. Untreated plants produced 37 percent borer-free ears in the same period. Dual-fixed nicotine dust applied on the same dates was not quite so effective as the sprays. Second generation sprays were applied on August 5, 9, 14, 20 and 27.

A spreader increased the percentage of borer-free ears (64.8) as compared with cubé without a spreader (57.3). The untreated check produced only 9.7 percent borer-free ears. A pyrethrum spray was not effective. Dual-fixed nicotine dust applied on the same dates resulted in 75 percent borer-free ears in contrast to 40 percent on the untreated check.

Date of Planting Experiments

For the third successive summer, corn maturing during August was not seriously damaged by the corn borer. Corn picked during July and September was heavily infested. As a general rule, it does not appear to be profitable to spray or dust corn to be picked in August. Results of the three years' tests of date of planting will be summarized for publication.

The Corn Ear Worm

Again in coöperation with the U. S. Department of Agriculture, the Station carries on studies of the corn ear worm. The infestation was light at Mount Carmel in 1937. The first generation appeared much earlier than usual, but there was not the expected increase in population; hence no data on controls were obtained.

Control of the Squash Bug

Work on the squash bug has been directed toward practicable control and a study of the bionomics with particular reference to the Tachinid parasite. Early laboratory work pointed to concentrated pyrethrum sprays and dust as the most effective insecticides against this bug.

Experiments of the past two seasons have proved the effectiveness of these materials under field conditions. The 1936 field tests tended to confirm previous findings but were not as satisfactory as those in 1937, when the plots were arranged and cultivated with comparison in mind.

Three pyrethrum insecticides (1) kerosene extract of pyrethrum, containing 2.4 percent pyrethrins, emulsified with Ultrawet; (2) this same pyrethrum concentrate in a dust form; and (3) a proprietary pyrethrum spray, "DX", were used, good control being obtained in all cases. The insect population in the treated plots was markedly reduced, and this was reflected in the yield which continued a month after untreated plants ceased producing.

Population studies of the squash bug and its parasite, *Trichopoda pennipes*, were continued. Observations during the 1937 season materially added to the evidence that this parasite is of more value in the biological control of the squash bug than was formerly supposed.

Onion Thrips

Spray applications for the control of onion thrips were successful when applied before the pests seriously injured the onions. Sprays used contained: 4 pounds of pure ground cubé root (4 percent rotenone) in 100 gallons of water with a petroleum sulfonate spreader (*Ultrawet*), or a sulfonated diphenyl spreader (*Aresket*). Three or four treatments at weekly intervals killed thrips, kept the population low, and gave a marked increase in yield. The addition of wettable sulfur increased the mortality of thrips in hot weather, but reduced the mortality in cool weather. Nicotine sulfate, 40 percent at 1-800, in sprays, killed many thrips but had no residual effect and the population increased rapidly.

Substitutes for Lead Arsenate in Orchard Sprays

The search for insecticides that will give as good control of insect pests as lead arsenate continues. This season emphasis centered on the application of derris dusts in July to control apple maggots. Regular sprays were discontinued after June 15 and .5 percent rotenone dust was used in three applications during July and August. At the Station farm the results were better than for several years past. At West Woods, where a similar schedule was followed, reduction of injury amounted to approximately 38 percent.

Control of the Potato Flea Beetle

Irish Cobbler potatoes were used in a series of experiments to control the ever-present potato flea beetle. Results indicate (1) that cubé dust, .75 percent rotenone, was more effective than cubé spray, one pound pure ground cubé root, 4 percent rotenone, in 25 gallons of water; (2) that cubé dust, .75 percent rotenone, was more effective than barium fluosilicate dust, 1 part barium fluosilicate and 4 parts hydrated lime; and (3) that the addition of a petroleum sulfonate spread, *Ultrawet*, to cubé dust at the rate of one part in 1000 parts of dust increased the effectiveness and reduced the amount of feeding by flea beetles.

Insects that Attack the Tobacco Plant

Work on insect pests of tobacco continued during the summer of 1937. This involves studies of the potato flea beetle, tobacco thrips, and the eastern field wireworm. The Federal Bureau of Entomology and Plant

Quarantine has stationed an entomologist at the Substation at Windsor to cooperate with the Station entomologist. (See Tobacco Substation.)

Inspection of Nurseries

Connecticut statutes require persons conducting nursery businesses in the State to register at the Station, and all such nurseries are inspected for insect pests and certified each year. Since July first, 377 of those registered have qualified. Several were discontinued in 1937 and a number of new ones have been started.

Inspection of Orchards

Regularly during the spring and summer, members of the staff visit many commercial orchards in the course of their work. Parasites are released in some places and check on these made later in the season; sprays are sometimes tried out in commercial orchards in different parts of the State; investigations of disease and insect pests require frequent examination of conditions in more than one location. In addition, growers report new developments, and frequently ask special consideration of their problems. Although advice and help must come largely through the Extension Service which was established for that purpose, the departments keep in touch with growers by answering requests as often as time permits.

Inspection of Apiaries

In 1937 inspection of 1,437 apiaries, containing 10,253 colonies, was carried out by the two inspectors appointed by the State Entomologist. Each man covered four counties visiting some apiaries more than once. American foul brood was found in 95 places with 221 colonies.

Spring Clean-up and Inspection of Corn Fields

Section 2125 of the General Statutes provides that all persons who plant corn shall clean up corn stalks, cobs and stubble on or before April 25 of the following year. Stalks should be cut flush with the ground and the debris burned, buried, or plowed under so cleanly that no stubble is visible; or the stalks may be run through a silo cutting them into small pieces for use as fodder.

Inspection to enforce the Statute began April 26, when ten men working under two members of the staff, set out on a tour of inspection. The entire State was not covered since little corn is grown on the higher elevations and most of the damage has been done along the coast and in the river valleys. Consequently, about 70 towns were visited during a period of four or five weeks. As a result about 50 growers were brought into court and were ordered to clean up their fields within two or three days. Most of them complied. About 10 were prosecuted and fined or ordered to pay costs.

Control of Gypsy Moth (In coöperation with the U. S. Department of Agriculture)

As in former years, the State's crew of trained workers has carried on a vigorous campaign to control the gypsy moth in the eastern portion of

Connecticut. Federal forces have covered the western part. Considerable work has also been accomplished by men from CCC camps. The many new infestations discovered were small and not particularly dangerous because they were situated in places where there was little chance of spread. Altogether, these men scouted 109 towns, discovered 536 infestations, creosoted 386,402 egg-clusters, sprayed 36 of the more important infestations with 83,202 pounds of lead arsenate, crushed by hand 1,192,069 caterpillars and pupae, applied 648,419 burlap bands, scouted 3,494 miles of roadside and 698,772 acres of woodland and cleaned 2,348 acres of woodland.

Although there was heavy defoliation in Maine, Massachusetts and New Hampshire, the only defoliation in Connecticut was of about four acres in Granby.

Control of the Asiatic Beetle

The Asiatic beetle continues to be a major pest of lawns in certain localities. More than 50 lawns inspected were found infested by this beetle. Most of them were in New Haven and West Haven, and instructions as to the proper lead arsenate treatment were given to owners. Other than this service, no official control measures have been attempted.

The insect is now known to be present also in Bridgeport, Greenwich, Hamden and Hartford, and recently a large infestation has been discovered in Springfield, Massachusetts.

Stickers for Standard Spray Mixtures

Laboratory studies of adhesive qualities of a number of recommended materials are under way. In addition, the value of various stickers for holding arsenic on foliage is being investigated in coöperation with the department of Analytical Chemistry. We now have two seasons' work in hand but much more needs to be done with this project before definite conclusions can be drawn.

FORESTRY

Control of the Dutch Elm Disease

On the whole the outlook for control of the Dutch elm disease in Connecticut is encouraging. During 1937, there have been three lines of activity which have required direct or indirect supervision by the Station Forester.

Coöperation with the Federal Department of Agriculture has continued, as in 1936. The Federal men located and eradicated 120 Graphium trees in the first ten months of 1937. The total for 1936 was 102. The increase was entirely in the towns of Darien and Stamford. In nearly every town having Graphium there were fewer cases. No infected trees were found in Branford, Guilford, Old Lyme, Ridgefield and Westport. The disease appeared for the first time in Redding, Ridgefield and Wilton, so close to the borders of previously infected towns that they do not constitute serious extensions of the infected area. On the whole, the situation seems more encouraging than it was a year ago.

The area covered by the Federal agents includes only a section along the shore from Greenwich to Lyme. A scouting campaign throughout the rest of the State was carried on by the Station during the summer of 1937. Eight men were employed and 89 towns were scouted twice between June 21 and September 4. Over 250,000 inspections of elm trees were made and samples were taken from 1,379 trees. Of this number, 376 appeared to have symptoms that justified culture in the Station botanical laboratory, but no Graphium cases were found. Consequently, it seems fairly certain that the Dutch elm disease infections in Connecticut are confined at present to a zone within 10 miles of the shore, and mainly west of Bridgeport.

The third activity is the elm sanitation program for the purpose of destroying wood in which insect vectors of Dutch elm disease might breed. This has been carried on by the Federal Department of Agriculture, with the coöperation of this Station, in all the areas covered by federal scouts. It consists of the eradication of all elms more than half dead, either on public or private property. In some cases, the owner's permission has been secured to eradicate all elms from swamps or other areas where conditions seemed to warrant such action. Over 250,000 are reported to have been removed for sanitation purposes during the current year. Needless to say, the great majority of these trees are small and of little value.

Outside the controlled area, the elm sanitation program carried on by the WPA has required closer supervision by this Station. It is confined to publicly owned elms and includes the pruning of these trees, as well as the eradication of those in bad condition. During the first 10 months of 1937, this work was carried out in 101 towns. The total number of trees pruned is 34,432, and 1,662 trees have been taken down. The bark beetle population has been materially reduced, thereby diminishing the chances of Graphium infection in the towns covered. In addition, a great many men on relief have been kept busy on useful work.

An entomologist has been employed to investigate the larval and adult habits of the native elm bark beetle, a carrier of the disease. Data for practically the complete life history has been collected. Other experiments have determined the effect of temperature on the pupal state. Especially important from the viewpoint of dissemination of the disease is the study of the feeding and hibernating tunnels made by the adult beetles in healthy trees. A bulletin on the findings will be published during the coming year.

The Forestry Department has had complete coöperation from the Botanical and Entomological Departments in carrying on this control work.

The Rainbow Experimental Forest

During the year measurements have been made and data secured to complete the progress report on Rainbow, which should be ready for publication early in 1938. It will cover the results of a 35-year period during which experiments on this tract have been carried on.

Several new projects in silvicultural treatment which are the beginning of a new series of experiments were laid out. These will materially increase the value of the tract from the research standpoint. They include the handling of white pine stands to determine the conditions under which

this species will reproduce itself satisfactorily by natural seeding. This involved the establishment of a considerable number of small plots on which the main crown cover, the undergrowth, the litter and the mineral soil were treated in various ways. White pine is one of the most valuable species in northeastern United States but comparatively little is known of the factors which govern its regeneration by natural means. It has been planted extensively but that type of regeneration is expensive and the results usually are not so good as those obtained where this species comes up naturally in dense stands.

Mundy Hollow Forest

Camp Britton, which was located at Mundy Hollow, became inactive as a CCC camp on June 1 of this year. It is probable that the Trustee will dispose of this tract as the land has little or no value for experimental purposes.

Distribution of Forest Planting Stock

Beginning in 1906, for 31 years the Station has maintained a nursery from which forest planting stock has been supplied to Connecticut land owners at reasonable prices. This was one of the many enterprises in which the Station pioneered. When Congress enacted the Clark-McNary Farm Forestry Law, this service became coöperative with the Federal Government.

Farmers and other landowners in Connecticut purchased 402,000 trees from the Station in 1937. This represented an increase of 71 percent over the 1936 demand and a three-fold gain in farm patronage. The stock in the Station nursery at Windsor was supplemented by purchase of a small amount from outside sources. In addition, the 35,000 trees were exchanged with the State Forester for other stock not available in our nursery.

A very large proportion of the several thousand successful plantations made in Connecticut during this third of a century was set with trees secured from the Station. Therefore we have a record of the date planted, the location and the species used. To these may be added the records of plantings made on public land. These constitute a most valuable set of trials. For several years the Station foresters have been studying these plantations in an effort to evaluate the various species, the systems of planting, the management, injury from pests, and the sites. Progress has been slow for it is a tremendous task, but the work has been speeded up with help of the WPA and CCC.

One phase of this project is a study of the rate of growth of red pine. The State Forestry Department and the Yale Forestry School have cooperated very effectively and the data will soon be ready for publication.

Preservative Treatment of Fence Posts

The loss of the chestnuts from this section of the country has meant, among other things, the substitution of other kinds of wood for posts. Durability is a major requirement and for several years the Forestry Department has been carrying on investigations, testing different types of

wood for this use, and devising methods of treatment that will make native wood as durable as imported varieties. The project has lagged in 1937 because of the reduced number of CCC men available as helpers, and lack of adequate supervision. In fact, it has always been handicapped by insufficient funds, but its value to woodland owners, post users, and commercial interests is becoming recognized. Efforts are now being made to secure financial coöperation from such sources. If these are successful, it should be possible to complete the project.

White Pine Blister Rust

The blister rust situation in Connecticut is definitely under control. The Federal emergency funds made available for this work during the past few years, in addition to the regular state allotments, have permitted extensive survey and mapping which is essential to a well-planned control program; and the amount of currant and gooseberry eradication accomplished kept blister rust infections down to a point where white pine may be profitably grown. Continued control work covering all pine areas at intervals of varying length will be necessary to maintain this condition.

There were five control projects in 1937: Wild Ribes eradication including nursery sanitation; pine type mapping; infection survey; painting of control area bounds; and the cruising of sample areas in Norfolk. The work was done with WPA, CCC and Resettlement Administration labor under direction of the Station.

The wild Ribes eradication was conducted in 30 towns on 57,859 acres of land and gave protection to 9,732 acres of white pine. Ribes are a menace to white pine growing within 900 feet. One stage of the fungus can develop only on the leaves of Ribes. Hence these plants are carriers and must be removed. In all, 212,695 wild Ribes and 820 cultivated Ribes were destroyed. In addition, six nursery sanitation zones were rechecked and 990 wild Ribes destroyed on 2,046 acres.

The pine type mapping was done in 22 towns. There were 264,474 acres examined but not mapped because of absence of pine, and 65,377 acres of pine and control area mapped in detail. These maps provide the basis for future control work.

The Pine Infection Survey, started the previous year, was completed in 1937. This year 5,213 acres of white pine were examined in southern Connecticut, on which were found 1,228 infected trees having a total of 1,941 cankers. The completed survey provides a picture of infection conditions in the State and will furnish the basis for future control plans.

Painting of control area bounds was done for the purpose of identifying these areas in the field. They outline 900-foot zones surrounding pine types. Seventy-four miles of such bounds were painted.

Cruising of pine areas in Norfolk covered nine and one-half acres. From data obtained, an estimate of the volume, growth and value of white pine in Norfolk will be approximated.

European Pine Shoot Moth

In coöperation with the Entomology Department, the control work on this insect is being carried on in much the same manner as during the preceding year. Essentially, the program consists of scouting and eradication.

Scouting is carried on from September 1 to April 15. This is accomplished in northern Connecticut by a man assigned from the Station, with small details of men from the CCC camps to assist him. In southern Connecticut, it is done by WPA scouts under the supervision of the Station. Based on the scouts' reports, an eradication program is carried out with WPA and CCC labor during May and June.

Except for portions of New Haven and Fairfield counties, the insect is pretty well under control at the present time, although there has been a slight increase in intensity and distribution of infestation during the past year, probably due to favorable climatic conditions. At present it seems wise to discourage the planting of red pine in most of New Haven and Fairfield counties, but elsewhere in the State the control of this pest appears to be practicable. Consequently, red pine may be used for forest planting purposes with less hazard in north and west Connecticut. (See also Entomology, p. 296.)

PLANT BREEDING

Hybrid Sweet Corn in 1937

MANY new inbreds of early varieties of sweet corn have been tested during the past year by crossing with Connecticut No. 2 inbred. Some of these hybrids are outstanding in uniformity and early maturity of good-sized ears. The most promising of these will be tested further and crossed with other inbreds. Many lots of hybrid sweet corn, a number of which are now commercially available, were tested during the past season at the Station farms at Mount Carmel and at Windsor.

In the first early season Gemcross 13, Gemcross 6, Marcross 13.6, Marcross 6 and Marcross 3 proved to be the most promising. For future production Gemcross 13 and Marcross 13.6 are particularly recommended. Somewhat later in ripening were Spancross 2, Spancross 39, Seneca Golden, and Early Bancross 39. The last two are outstanding for quality.

Of the many midseason hybrids Marcross 13.39, Sencross 39, Suncross 39, Whipcross 6.2, and Whipcross 39 are among the best. Golden Cross Bantam, Bloomcross 39 and Bantam Evergreen crosses are the most satisfactory for late production. Golden Cross Bantam produces the largest number of ears of the best quality. The other two have longer ears.

Hybrid Field Corn in 1937

The use of hybrid field corn seed has increased much faster in the Middle West than in New England in the last few years. This is due chiefly to the fact that corn is raised there for grain. The superiority of hybrids is not so apparent in ensilage corn. Many of these western hybrids grow very well in Connecticut. Some have a remarkable ability to stand erect throughout the season. The best are slow growing and not so productive as the finest local types. Crosses between these erect western inbreds with local types and with the late southern prolific varieties are being tried for both grain and ensilage with promising results.

Increasing the Yield of Inbreds

Many of the inbred strains of corn now extensively used in the production of both field and sweet corn would be more useful if they were more productive in their inbred condition. A method of improving inbreds, not only in yield but in other desirable characters, is being tried out. This method, called selection in back crossed lines, consists of crossing the inbred with other inbreds or varieties that have the qualities the original strain lacks. These outcrossed plants are backcrossed to the strain to be improved for several successive generations selecting for the characters desired. This is done on an extensive scale in a crossing field, saving only plants that have qualities sought.

An Early Summer Squash

Seed of Connecticut Straightneck Squash has been increased by seedsmen and at the Station so that growers may obtain supplies for their 1938 plantings. Connecticut Straightneck is an inbred selected from a hybrid between a giant crookneck and an inferior straightneck. It is pale yellow in color, about 10 inches long and is ready for picking a week earlier than its best commercial rival. In total number of fruits and weight it also compares favorably with the best standard squash.

Improving the Shape of Peppers

The Windsor strains of peppers developed by the Station have proved to be remarkably productive in Connecticut and under favorable conditions in other states. At the Windsor farm in 1937, a yield of 13,000 pounds per acre was obtained in the first part of the picking season and 23,000 pounds for the entire season. While Windsor has smooth, thick walls, it is not the most desirable shape. The market demands a more blocky type of fruit. In order to add this quality to those mentioned, the Windsor pepper has been crossed to Oshkosh and backcrossed to the original type. Selections in these backcrossed lines are being made for a better fruit shape.

New Strawberries in Connecticut

Out of the fourteen strawberry selections noted as promising in the previous report, three have been selected for further testing. These are numbers 111, 143, and 282. The first two have outstandingly attractive fruit and the other is more productive than the varieties commonly grown. Further tests on many types of soils and in different seasons are needed to show their adaptability and general usefulness.

Preliminary experiments indicate that wide spacing of plants has a direct bearing on yield. At Windsor the Connecticut strains made a matted row of sufficient width when planted as far as three and one-half feet apart in the row. In this trial three and one-half feet were left between rows, and the plants in the different lots were spaced two and one-half, three, three and one-half and four feet apart in the row.

The maximum yield came from the three and one-half foot spacing with the three-foot spacing second. This experiment will be run for several years on different kinds of soil.

Studies in Improvement of Garden Beets

One of the projects under way in this department is the perfecting of methods for inbreeding garden beets and the development of lines with high pigment and sugar, and non-fibrous tough flesh. These are fundamental problems of seedsmen as well as of those who grow beets for market and canning.

Before we can make selections for color, or make hybrids between different types and then select for color, self-fertile inbred lines must be obtained. Plant breeders find beets very difficult to work with because they are highly self-sterile. Very few of the hundreds of individual plants that we have attempted to inbreed have been able to reproduce themselves through more than two generations of inbreeding.

At present 25 different families with a fair degree of self-fertility have been isolated. A sample of 10 roots has been analyzed for color from 95 different lines within these families. The mean pigment content of these lines ranged from 0.25 to 1.55 percent. This indicates that color in garden beets is at least partially controlled by genetic factors and that strains of known pigment content can be isolated. We do not know, however, just how much influence different environmental factors have upon the expression of these genetical factors for pigmentation. For instance, we cannot say whether high or low nitrogen content of the soil intensifies this pigment or whether it is reduced. This is true for phosphorus, potassium and other elements. Neither do we know definitely whether spring-grown beets have less pigment than the fall-grown crop. Perhaps length of day, temperature, and rainfall also influence the production of pigment in the roots.

Already this department in collaboration with the Department of Biochemistry has perfected methods for determining the amount of pigment in beets. (See Biochemistry, page 282.) Since we have self-fertile families whose pigment content is known, we have outlined experiments to solve some of those problems that constantly concern seedsmen, breeders and growers in the production of beets of uniformly high pigment content.

Changes During Seed Development

Previous studies on somatic segregation have shown many genetic changes in the seeds of maize during development. It has been found that color changes are sometimes accompanied by growth changes whereby some of the cells either fail to fill out properly or are increased in number so as to form outgrowths of various kinds. These somatic changes result from unequal cell division whereby some of the inherited determiners are either lost or shifted in such a way that they are increased in number. The exact process by which this unequal cell division takes place has not been determined but for the most part it seems to be associated with chromosome breaking and rearrangement.

When part of a chromosome is removed from its normal position, the resulting cells are highly unstable as shown by frequent losses and shifts of genes on the remaining part of the same chromosome. Any external agent such as radiations, chemicals or the excretions of parasitic organisms that can enter the cell without killing it may affect the mechanism of cell divi-

sion so that the chromosomes are not properly divided. The result may be a permanent change in the ability of the cells to coordinate growth.

Changes of this kind have an important bearing upon the stability of vegetatively propagated fruits, flowers and vegetables. Since most of these plants are hybrids between diverse parental types, somatic losses of dominant genes change the plants not only in appearance but in ability to grow and to produce.

Effects of Inbreeding

Strains of corn have now been self-pollinated for 30 successive generations. No noticeable decrease in height of plant took place after the fifth generation but yield of grain steadily declined to the twentieth generation. After that no significant changes have occurred in two lines. In a third, a slight but consistent alteration in the formation of the ear has occurred. The ears in one of two lines separated from this strain in the fifteenth generation are not so well filled with seeds as the other. The plants with the poorly filled ears are slightly taller than the plants of the related line. These differences have persisted for 15 generations and have resulted from some permanent change. This germinal alteration is a degenerative or loss variation. No progressive or favorable variation has occurred in these long inbred strains.

Inbred strains of corn are excellent material in which to study variations of all kinds since they are quite uniform and are so reduced in size that outcrossing with any other plants is immediately detected in the next generation.

SOILS

Testing Soils in Connecticut

THE Universal Soil Testing System, developed at this Station, is now being used in 17 states, with modifications in technique to meet local soil conditions. It has also been adopted by numerous commercial concerns, such as fertilizer companies and processing plants, as a service to their clientele.

The methods for quick chemical soil examination developed at this Station, designated as the Universal Soil Testing System, were further refined in 1936, and revised procedures were published as Bulletin 392.

Promising new tests for manganese, copper, zinc and boron have been included. During 1937 approximately 1750 soils were tested at New Haven and about 3500 at the Tobacco Substation. The same methods were applied to 5000 samples examined by the Extension Service of the Connecticut State College, and results were widely applied to practices for which soil-conserving payments were made in the 1937 AAA program. Tests obtained during the past year at the various centers of soil testing have indicated material improvement in the conditions of chemical fertility on many Connecticut soils as a result of improved soil management practices during recent years.

Leaching Losses in a Year of Excessive Rainfall

The winter of 1936-37 and both the summer and fall months of 1937 have been notably above normal in rainfall at the Windsor Substation

where the lysimeters of the Soils Department are located. This has supplied an opportunity to find out whether the excessive leaching during these periods has resulted in unusual losses of certain constituents from the soil.

After the summer and fall of 1936, with normal rainfall, practically all of the nitrates liberated during the period had leached from the surface soil. Hence, percolations of eight inches or more during the months of December, 1936, and January, 1937, carried downward less than 10 pounds of nitrate nitrogen per acre in all cases. Deeper soil layers had retained some of the nitrogen lost from the surface during the earlier period and this was practically all removed by the unusually heavy winter leaching.

Since, under ordinary conditions, spring thaws and rains leach the subsoil quite thoroughly, the chief result of the mild, wet winter was an abnormally early removal of nitrates from the entire soil profile. Total losses of various constituents during the year ending in May, 1937, were not significantly greater than had been noted in several previous years with a much smaller volume of leaching. Thus, it can be stated that unusually heavy winter rainfall does not result in excessive losses of chemical substances.

On the other hand, the heavy rains of June, August, September and October rapidly removed nitrates from the surface soils. Two-hundred-pound applications of nitrate nitrogen as nitrate of soda, applied on May 26, were almost entirely leached out by August 12, and more than half was lost during the month of June. Nitrates from the more slowly available nitrogen sources, such as cottonseed meal and urea, suffered June losses of less than 20 percent, but had been practically removed from the surface soil by the end of August. Further heavy leaching in September and October indicated that little more soluble material was being carried downward. Leaching from the subsoil did not begin to remove much of the nitrates until September and October.

The quantities recovered in the drainage during the latter period indicated that the soils are entering the winter season in a state of depletion of soluble substances comparable to that usually attained at the end of the normal period of heavy leaching during the following spring.

The growth of cover crops has been unusually effective in conserving residual nitrates not removed by cropping. This subject will be more fully discussed in the report of the Tobacco Substation.

Coöperation with the Soil Conservation Service

The Scantic River watershed in Hartford and Tolland counties has recently been developed into a federal demonstration area under the administration of the Soil Conservation Service. Soil erosion surveys had previously identified fields and farms where the loss of soil was becoming a serious problem, and a competent staff, with Mr. John A. Brenneman as Project Manager, is now planning suitable control measures for the 1938 season. The Soils Department has coöperated in both the survey and the instigation of the project.

In addition to the above, a special survey of soil erosion problems under orchard conditions is now under way, with areas in Middlefield and Wal-

lingford completed during the fall of 1937. The work is to be continued in the spring of 1938.

Apple Orchard Soils in Connecticut

Commercial apple orcharding is an important feature of the agricultural scene, especially in the towns of Wallingford, Cheshire, Middlefield, Southington, Berlin and Glastonbury. During the past year, a group of 12 soils from mature orchards has been under special study. These were selected as typical of the various soil types most commonly planted, including the Charlton, Brookfield and Gloucester loams of the eastern and western highland, and the Cheshire fine sandy loam and Wethersfield loam, hill soils of the central lowland.

Although all orchards selected had been in successful operation for 25 years or more, the soils varied widely in physical and chemical properties. The degree of chemical soil fertility was generally reflected in the condition of sod cover between the trees. Inferior, sparse herbage was the rule, readily explained by the strong acidity and serious phosphorus deficiency prevailing.

Seven of the twelve orchards were more acid than 5.0 pH, ranging from 4.26 to 4.93. The least acid soil was at 5.27 pH. An abnormally poor phosphorus availability appeared to be related to excessive acidity. Past treatment with manure, basic slag and other mineral fertilizer applications accounted for most of the variations. However, soil taken from under a sod recently top-dressed with a complete fertilizer was especially phosphorus deficient as measured by both chemical soil examination and growth response of tobacco grown as a test crop. Apparently the fertilizer had not penetrated the sod in this case. It is of interest to note that the only soil giving reasonably satisfactory growth of the test crop without phosphorus had been treated with both basic slag and manure a number of years before.

Five of the twelve soils were markedly deficient in potash. However, in general, the apple orchard soils appeared to be less potash-responsive than most field soils not especially fertilized with potash.

The residual available nitrogen in these soils was reasonably good, although liming definitely improved the liberation of this element.

In common with previous results, there was no apparent correlation between soil type and chemical conditions of fertility. However, the physical factors of soil texture, moisture-holding and base-absorptive capacity and humus content were generally consistent with soil type identifications in the field. The orchard soils averaged somewhat superior in organic matter, porosity, moisture-holding capacity and base absorption to other groups of soils previously studied. Thus, orchard soils with 2.66 percent total carbon in the upper 10 inches surpassed potato soils, sampled to only a seven-inch depth, by more than 25 percent.

It is now possible to make a comparison between several groups of soils, subjected to identical methods of study, by greenhouse pot technique. As an illustration, the following table shows relative yields for each cultural use, on the basis of the results over a seven-year period during which essentially the same methods have been employed.

	Without Nitrogen		Without Phosphorus		Without Potash	
	Unlimed	Limed	Unlimed	Limed	Unlimed	Limed
12 Pasture Soils	61.4	84.5	20.3	24.2	59.9	42.5
14 Grass Hay and Corn Soils	95.9	100.0	15.5	43.9	54.0	46.6
12 Apple Orchard Soils	72.3	95.3	14.6	14.7	92.0	75.6
13 Peach Orchard Soils	77.1	93.4	26.5	36.1	89.2	66.9
10 Alfalfa Soils	59.8	70.1	26.6	22.8	59.8	51.1
13 Potato Soils	55.9	66.2	35.4	22.1	100.0	68.9
8 Vegetable Soils	67.5	72.4	63.0	66.3	98.4	85.4

It is of interest to note that cultural practices in corn and grass hay rotations, common in dairy farming, have given the highest level of nitrogen availability, while poorest conditions in this respect are shown by continuous potato growing. Phosphorus is apparently poorest under apple orchard conditions and best under vegetable cropping. Lime is able materially to improve phosphorus availability on soils in dairy rotations, while on potato soils, previously receiving liberal phosphorus fertilizer under acid-soil conditions, liming has a distinct tendency to restrict the availability of this residual phosphorus. It is notable that liming has decreased the availability of potash in all cases. A detailed review of these experiments is being compiled for publication.

Vegetable Fertilizer Results at Windsor

The field season of 1937 represents the eighth year of soil fertility trials with vegetables at Windsor. The experiments with manure, lime and fertilizer rates and concentrations have given results in line with those reported previously, except as follows: The abnormally wet season caused serious leaching of available nitrogen. Consequently, heavier rates of nitrogen were especially effective, and concentrated fertilizers supplying no organic nitrogen were less desirable than usual. Significantly beneficial results followed the practice of adding an early spring nitrogenous topdressing to the winter cover crop of rye.

Soil Amendment Trials

The experiments with organic soil amendments, carried on for three years on sandy plots, were transferred to a new location this season. The tests failed to give significant data where soil moisture was adequate. However, as on sandy soils, tobacco stem meal was especially beneficial, even when its rich potash content was counterbalanced by corresponding potash treatments on the check plots. Other materials used in these experiments were stable manure, dried cow manure, and commercial native peat.

Sweet Potatoes

The commercial production of sweet potatoes in this State is recent and the crop is therefore the object of special fertilizer study. A series of tests conducted during a three-year period has confirmed the results of older trials in the Middle Atlantic States. Best yields and quality were produced when 1200 pounds of a 2-6-10 analysis fertilizer were applied. The following data represent the three-year average acre yields of market-

able short-stem Jersey sweets in the above experiment, using 1200 pounds of fertilizer of the formulae indicated:

2-6-10	244 bu.	4-12-10	224 bu.
4-6-10	220 "	4-6-10 side-dressed	230 "
8-6-10	203 "		
4-6-6	225 "		

These results were secured on a soil area that was considered too sandy for successful tobacco production.

It is of interest to compare yields with those obtained from a somewhat more favorable soil in the regular vegetable crop plots. Here the average for all plots during the past five years has been 316.5 bushels per acre. In the latter trials a phenomenally high average yield of 429 bushels was obtained from heavily manured plots, but the quality of the potatoes was consistently low due to poor shape and greater prevalence of soil-stain disease. The best quality yield was 323 bushels per acre when 1500 pounds of a 6-6-12 fertilizer were used. In this experiment, lower nitrogen applications resulted in decreased yield, but improved quality.

Declining Yields of Potatoes under Continuous Culture

A series of potato fertilizer ratio plots has been conducted since 1933 on a field formerly in continuous tobacco culture. Yields in 1937 were disappointingly low on all plots, and it is believed that this was largely due to the depletion of active soil organic matter resulting from five successive years of potato culture. Standard treatment plots, receiving 100 pounds of nitrogen, 120 pounds of phosphoric acid and 120 pounds of potash per acre, have fallen from 377 bushels in 1933 to 133 bushels in 1937, with an average of 248 bushels for the five-year period. In comparison, potatoes grown for the first year after tobacco on an adjacent field of similar soil gave 215 bushels per acre in 1937.

In the above trials the most conspicuous result has been the increased response to potash from year to year. For the first year or so there was a large residue of readily available potash left over from tobacco fertilization. Hence yields without potash were not significantly poorer than where increments of this constituent were applied. The following data show the increases in yield from 120 pounds of potash, as compared with "no potash" plots: 1933–7.3 bu.; 1934–18.2 bu.; 1935–28.9 bu.; 1936–65.2 bu.; 1937–61.1 bu. In 1937 the yield without potash was only 72 bushels per acre.

On the other hand, the residual phosphorus from tobacco culture has been much more durable. In fact, the yield in 1937 with no phosphorus was less than one bushel below the most favorable rate of phosphorus application, which has consistently been only 40 pounds of P_2O_5 per acre.

As a corollary to the idea that declining yields were associated with soil organic matter depletion, it is noteworthy that plots receiving half of the nitrogen as cottonseed meal, rather than all from inorganic sources, gave unusually good results this year.

Special Magnesium, Lime and Phosphorus Experiment on Peppers

Windsor-A peppers (see page 306) were grown on a series of small plots at Mount Carmel, variously treated with respect to magnesia, lime and

phosphorus. Naturally this soil is strongly acid, exceptionally poor in magnesium and fairly deficient in phosphorus. The use of magnesium, as magnesium sulfate, supplying the equivalent of 75 pounds of magnesia per acre, resulted in an increased yield of 648 bushels per acre. When magnesium was supplied, the use of a high-calcic limestone sufficient to bring the soil from 4.9 to 6.3 pH produced a gain of only 143 bushels per acre.

Phosphorus was more beneficial to the acid soil than to the limed soil, the increase being 330 bushels in the former and 228 bushels in the latter case. In these trials the maximum yield on complete fertilizer treatment at 6.3 pH was 1516 bushels of mature peppers per acre, averaging 34 pounds per bushel. The rate of planting was equivalent to 40,000 plants per acre. At the best yields, approximately nine peppers per plant were harvested.

Forest Soils

Good growing conditions for trees are most likely to be maintained through silvicultural practices that favor rapid liberation and consumption of nutrients contained in the litter. This conclusion resulted from a study of data obtained during three years in which lysimeters were in operation in a red pine plantation. It is estimated that in a 20-year stand, approximately 4000 pounds of litter which collects each year contains from 55 to 60 pounds of nitrogen, 30 of calcium, and 15 of potassium. Of these amounts, an average of 16 pounds of nitrogen, 30 of calcium and 15 of potassium are leached into the mineral soil.

Indications are that most of this material was absorbed and held by the first four inches of mineral soil since the amount obtained from the soil and litter together was, in general, not greater than that from the litter alone. With root competition, nitrates constituted 50 percent or less of the total nitrogen content of the leachate; without root competition, nitrates amounted to as much as 75 percent of the total. Quite a sizable percentage (up to 57 percent) of the total occurred as organic nitrogen.

With respect to season of the year, the largest amount of soluble nitrogen was obtained in summer and early fall, presumably on account of the greater microbiological activity stimulated by high air temperatures.

Actual losses through deep percolation were practically nil because roots absorbed the nutrients as quickly as they were found. This, together with the fact that nitrification and solution take place slowly, explains why forest soils almost always test low in soluble nutrients.

Soil Factors Affecting Tree Survival in Forest Plantations

Studies of the relationship between tree survival and soil characteristics, such as type, texture, moisture equivalent, acidity and topography are being continued. To date the chief controlling factor appears to be moisture, the poorly-drained sites being less favorable for Scotch pine, red pine and Douglas fir and slightly more favorable for larch than the well-drained sites. Soil types as such are not a factor except where strikingly different as shown by the moisture equivalent determinations. Further analyses may reveal relationships not yet apparent. It is expected that the data to be obtained on subsequent growth of these trees will be of added value in governing plantings in the future.

Response of 18-Year-Old Red Pine to Fertility

Latest measurements of the growth of 18-year-old red pine on Merrimac coarse sand fertilized annually since 1931 show that height was not affected by fertilization except where lime was included. With lime added there was an average gain of about 0.4 foot. Diameter growth, however, has been favored slightly as indicated by the following data:

Treatment	Av. D. B. H. inches
NPK	3.89
2(NPK)	4.05
LNPK	3.96
N	3.73
2N	3.87
Check	3.68

This poor showing of fertilizers on a soil low in fertility may be ascribed to three important factors: (a) Insufficient moisture; (b) loss of fertilizer through leaching, and (c) low requirement of red pine trees.

Effect of Treatment upon Subsequent Growth

Red pine trees, which had been fertilized in the nursery, have been growing in the field since 1933 on Merrimac coarse sand. Earlier measurements showed no carry-over effect of treatment on subsequent growth. However, at present, there is some indication that nursery fertilization was beneficial, especially where such materials as fish meal, a 20-8-8 mixture plus lime, 20-8-8 alone, or sulfate of ammonia were used. A number of trees were fertilized with an additional 11-6-6 mixture, applied biennially at the rate of 400 pounds per acre. This resulted in an average increase in height growth of about one inch; viz., 29.22, height of treated trees, as compared with 28.09 inches, height of check trees.

TOBACCO SUBSTATION

THERE are hundreds of types of tobacco grown in the world but only three of them are grown commercially in New England. Many trials of other varieties have been made here by experiment stations and by individual growers and a few have been partially successful for a year or two before being rejected by the trade. The three that have attained a permanent place in the last century are Broadleaf in 1833, Havana Seed about 1875 and Shade in 1900.

A new type, called RC, is being grown commercially for the first time this year on some 250 acres in Connecticut. Time and the cigar manufacturers will determine whether RC is to have a place among New England tobaccos.

RC tobacco was developed and introduced by Mr. Joseph Rosenberg after many years of experience in the growing, manufacturing and handling of tobacco. It is designed for use as a cigar wrapper but is not grown under shade cloth and therefore is much less expensive to cultivate than Shade tobacco.

The shape of the leaf is quite different from that of the three other Connecticut types. It has a distinct stem, petiole, by which it is attached to the stalk and has no "ears" which clasp the stalk like the other varieties. Mr. Rosenberg claims that this shape is better for cigar wrappers since there is less wastage in cutting this leaf than any of the other types. The lower part of the ordinary leaf and the ears are naturally useless for cigar manufacture. Moreover, in a large leaf like Broadleaf, a considerable area close to the midrib is wasted because the veins are too large. The RC leaves are small, like the Shade tobacco, and the veins are not prominent. The cost of harvesting is somewhat higher than for Havana Seed or Broadleaf because the leaves must be picked and sewed like Shade.

This type also has more leaves to the stalk and on the average about 25 are marketable. The plants are vigorous and hardy and appear to be less subject to insect injury, diseases and storms than the other varieties. In some test plots at the Experiment Station in 1936 the yield was about a ton to the acre. In the tests of 1937, the yield was about 25 percent lower, approximately the same as that of other types this year.

A Serious New Disease of Tobacco in Connecticut

Downy mildew has been prevalent in the more southerly tobacco states for several years where it has caused serious losses of tobacco seedlings. Long anticipated, it appeared in Connecticut for the first time in 1937. During the last week in May the disease suddenly developed here in destructive form and was found in all the tobacco growing towns of the State before the end of the seedbed period. It also spread to the fields during the excessively wet month of June and caused some field damage in Shade tobacco.

The Station began control experiments immediately and the methods used in the southern states were tested. Bordeaux mixture apparently gave unsatisfactory control. More promising results were obtained by the use of red copper oxide mixed with cottonseed oil and lethane spreader. Benzol vapor treatment was promising. A thorough study of the disease has been made and a Station Bulletin 405, giving available information, has been published and distributed to all growers.

Mosaic Resistant Tobacco

Mosaic, or "calico", is an ever present disease of tobacco in Connecticut. It varies in severity from year to year, but takes some toll from every farm every year. Although it rarely assumes major importance, the affected leaves are of little if any value when cured, and the loss in the aggregate is considerable. No adequate method of control is known. All our varieties of tobacco are equally susceptible and until a few years ago no variety in the world was known to be immune or highly resistant. Recently a South American variety called "Ambalema" proved to have resistant qualities. This suggested the possibility of developing a hybrid that would combine resistance with the desirable characters of our commercial variety.

A good strain of Broadleaf variety was selected to be crossed with Ambalema. The hybrid progeny (F_1) was grown to maturity but was not in-

oculated with the mosaic virus because resistance is known to be a recessive character and all the F_1 generation would naturally be susceptible. The seed from the F_1 generation was started in the greenhouse and when the plants were about one inch high, 800 of them were transplanted into a greenhouse bench (F_2 generation). Here they were thoroughly inoculated several times with virus-containing sap from diseased plants.

About 75 percent of them showed severe symptoms of mosaic and were rogued out. Many of the others showed mild symptoms—faint, indefinite, yellowish areas in the leaves. The most evidently affected of these were also rogued out and finally about 50 plants on which practically no signs of disease were visible were set in the field in June, 1937, and inoculated again. When they started blooming, late in the summer, some of those which had the most apparent Broadleaf characteristics and showed no mosaic lesions were back crossed on Broadleaf; others were bagged and selfed.

The F_3 generation and also the back cross will be grown in the greenhouse from these seeds. We have thus produced plants practically immune to the disease and quite similar to Broadleaf, but further selection and probably more back crossing will be necessary to get a commercially acceptable strain.

Further Studies on Pole Rot

Studies on the different types of pole rot, mentioned in the Director's report for 1935, have been continued. Work in 1937 concentrated on the vein-rot type of this trouble. This type, causing the midvein, and sometimes the large laterals, to decay, first becomes apparent in a softening of the veins accompanied by growth of fungus tufts on the surface. Species of Alternaria, Botrytis, Fusarium and Cladosporum are most common. Of these *Alternaria tenuis* has been most prevalent in recent years.

This species was isolated from the interior tissues of the vein, grown in pure culture and again inoculated into sterile veins where it produced the typical rot. Microscopic studies showed all the tissues of the vein invaded and finally destroyed by the mycelium, except for the woody xylem tubes in the center. This species is therefore demonstrated to be one of the fungi responsible for vein-rot.

Another fungus, *Botrytis cinerea*, commonly found on decaying veins, was isolated, grown in culture and, when inoculated into sterile pieces of veins, caused more rapid decay than Alternaria. Although not studied as fully as Alternaria, it also is undoubtedly responsible for pole rot. The pathogenicity of other species found on decaying virus has not been demonstrated. It is probable that there are a number of them, any one of which may be responsible for this type of the disease.

Further Studies on Soybean Oil Meal as a Fertilizer

Previous experiments with soybean oil meal as a fertilizer for tobacco have been very promising. Continued and more extensive tests emphasize the value of this material as a nitrogen carrier.

In 1937 this meal was compared with cottonseed on plots located in three different places on the Station farm at Windsor. The soil ranged from

very light sandy loam to medium heavy sandy loam. Results for the 1937 season, with a rainfall about 50 percent above normal, show that soybean oil meal produced over 300 pounds of tobacco to the acre more than cottonseed meal. Since the grading of the tobacco grown with soybean oil meal was considerably higher than that grown with cottonseed, it was calculated that the value of the crop was increased about 24 percent. The average for two years is about 23 percent.

One explanation for the favorable results with soybean oil meal is that this material maintains a higher level of nitrates in the soil than does cottonseed. This fact was brought out in a series of nitrate tests on soil samples taken at weekly intervals during the growing season. Moreover, in only one instance did the level of nitrates for the soybean meal fall below the equivalent of 20 pounds per acre, which is considered a minimum for proper growth. The nitrates on the cottonseed meal plots fell below this level at the beginning and again at the end of the growing season.

Further Calcium Tests

Continued experiments with calcium applications have demonstrated the importance of maintaining a certain calcium content in tobacco soils. For the second season (1937) the addition of 100 pounds CaO per acre increased the yield about 200 pounds. While in the previous year further additions of CaO caused no further improvement in yield, in 1937 a 300-pound application stepped the yield up 50 pounds. A 600-pound application showed only slightly higher yield.

Considering, moreover, that additions of calcium to the soil also improved the quality of the tobacco, it was shown that the acre value of the crop rose 24 percent through the 100-pound application, and 39 percent at the 300-pound rate. No further improvement was obtained with the 600-pound application.

Since the calcium was added in a mixture of landplaster and calcic hydrated lime, there was no appreciable change in soil reaction.

Effect of Cover Crops and Tobacco on Drainage Losses

Lysimeter experiments on the conservation of fertilizer elements by cover crops have been in operation since 1931. Results of the first five years are shortly to be published in a bulletin by the Soils Department and the Tobacco Substation.

The cover crops used were oats, rye and timothy, grown on tanks which had each produced a single tobacco plant. Nitrogen fertilizers used were calurea with oats, and a mixture of cottonseed meal, castor pomace and nitrate of soda with oats, rye and timothy. Tanks without cover crops were included with both series.

Cover crops were most efficient in conserving nitrogen and calcium, less so with potassium and magnesium. Oats and rye were about equally efficient, timothy considerably poorer, perhaps because of slower root development in the early fall.

Time of Harvesting Shade Tobacco

Preliminary studies to determine the best time to pick Shade tobacco were started in 1936 and show considerable promise. Pickings were

started on selected plants when the buds were in the cluster stage, but none showing color, and successive lots were started at the time of the first regular picking, and the second regular picking. These intervals were three and four days respectively. Later pickings followed at ten, twelve and nine day intervals in 1936, and twelve and five day intervals in 1937. The top picking was omitted this season.

Early picking produced thin tobacco of greenish cast on the lower stems, prominent veins and greasy dark leaves above. Considerably smaller yields were obtained.

Late picking of the lower leaves increased the yield but was disastrous to quality. The leaves were spotted and yellow. On the upper pickings they deteriorated rapidly in both grading and yield.

Medium pickings, started when the inflorescence had begun to show color and an occasional blossom was opening, were uniformly better. This is usually five days to a week after the more mature plants have reached the cluster stage and have been debudded. When operations began at this stage, the value of four pickings in 1936 was $1505 per acre. This figure exceeded the price of the early pickings by $190, and that of the late, by $227.

Potato Flea Beetle on Tobacco

Various insecticides were tried to protect tobacco from the potato flea beetle which takes an enormous toll from growers in the Connecticut Valley each year. On Shade tobacco, cubé root powder (1 percent rotenone) and tobacco dust, as well as this combination with clay on one-eighth acre plots gave adequate protection. Weekly applications at rates varying from six to ten pounds per acre, depending upon the size of plants, were used.

Treatments containing barium fluosilicate also repelled the beetles but left a white residue on the foliage.

Good protection on one-eighth acre plots of Havana Seed was obtained in tests of two rotenone dusts. Each contained one percent rotenone and one an activating and stabilizing material as well.

Tobacco Thrips

An attempt to reduce the molasses content of a nicotine sulfate mixture that controlled thrips on tobacco last year spoiled the effectiveness of the material. The change was made to correct a slight staining of the leaves. Of the several other materials tested, cubé root powder as a dust with a dry spreader gave most favorable results, with cubé spray second.

Wireworms

A number of toxic materials were tested as controls for wireworms. Naphthalene and dichloroethyl ether gave the most promise, the former being plowed into the soil, both spring and fall, and the latter used in the setter-barrel at time of transplanting.

Tobacco Insect Survey

A systematic survey of insect occurrence in the Connecticut Valley area was made by visiting five tobacco fields in each township.

THE LIBRARY

During the year ended October 31, 1937, the Station Library has had approximately the following number of additions:

U. S. Department of Agriculture bulletins and reports	885
State Agricultural Experiment Station publications	968
Scientific and agricultural domestic and foreign journals (separates)	2,795
Single books purchased	52
Total	4,700

The library subscribes to 89 sets of scientific journals. It receives in return for Station publications about 24 sets of domestic farm journals and 26 sets of foreign agricultural journals.

The total number of cloth and paper-bound volumes on hand is now about 26,000. Most of the United States Department of Agriculture and State Agricultural Experiment Station publications, as well as scientific journals, are received in pamphlet form and are not included in this volume count until bound.

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1937

Report of Commercial Fertilizers for 1936. E. M. Bailey. No. 390.

Tobacco Substation at Windsor. Report for 1936. P. J. Anderson, T. R. Swanback, and O. E. Street. No. 391.

The Universal Soil Testing System. (A Revision of Bulletin 372.) M. F. Morgan. No. 392.

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Connecticut State Entomologist. 36th Report, 1936. W. E. Britton. No. 396.

Commercial Feeding Stuffs. Report on Inspection, 1936. E. M. Bailey. No. 397.

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PROJECTS ACTIVE IN 1937-38

Analytical Chemistry

1. Inspection of fertilizers.
2. Inspection of feeding stuffs. (Including biological assays of fortified poultry feeds.)
3. Inspection of food and drugs. (Including biological assays of vitamin D milk.)
4. Calibration of Babcock glassware and thermometers.
5. Analyses of insecticides and fungicides.
7. Analyses of special and miscellaneous foods.
8. Collaborative studies on analytical methods.

Biochemistry

1. Cell chemistry.
   a. A detailed examination of the constituents of plant cells, in particular those of leaf tissues. The further development of methods for the determination of the different forms of nitrogen in such tissues.
   b. Chemical investigations of the constituents of the tobacco and other plants with special reference to the changes that occur during culture under various conditions.
   e. The metabolism of the organic acids in plants.

2. Protein chemistry.
   a. The methods for the determination of the basic amino acids yielded by proteins with the object of increasing their accuracy and convenience.
   b. The methods for the separation of other amino acids yielded by proteins.
   c. The properties of certain of the amino acids and their derivatives.
   d. Methods for the preparation of pure proteins.

3. Nutrition investigations.
   a. The relation of diet to the rate of growth with special attention to certain factors that appear to determine rapid growth.
   b. The investigation of the relation of certain constituents of the diet, in particular the mineral salts, to growth.
   d. An investigation of the effect of extracts of the thymus gland on the rate of growth of the offspring.

Botany

2. The nature and cause of mosaic diseases of plants. (Inactive.)
5. Plant disease survey of Connecticut.
8. Spraying and dusting experiments on apples and peaches. (See also Entomology, No. 3.)
15. A study of the virulence of the chestnut blight.
20. Diseases of shade trees.
27. Investigations of elm diseases.
28. Studies on the identification of apple varieties by seed characters.
30. Investigations of the diseases of vegetable crops and their control.
   a. The control of downy mildew of muskmelons.
   b. Further studies on the spraying of potatoes with Bordeaux—concentration of spray and time of first application.
   c. Cabbage yellows—comparison of strains to determine the resistance.
   d. Downy mildew of onions—comparison of fungicides as to control and to injury to the plant.
   e. Beets—tests of copper compounds for the control of leaf spot.
   f. Tomatoes—tests of copper compounds for the control of early blight and Septoria leaf spot.
31. Investigation of a new peach trouble ("X" disease).
32. Sand and other artificial culture methods of seedlings and growing plants.

Control and Service

12. Seed testing. (In coöperation with the Commissioner of Agriculture.)
25. Spray service. (With the Extension Service, Connecticut State College.)

Entomology

3. Spraying and dusting experiments on apples and peaches. (See also Botany, No. 8.)
9. Insect survey of Connecticut.
17. Studies on the control of the Oriental fruit moth, including parasites. (In coöperation with the U. S. Dept. Agr.)
28. Investigations on oil sprays.
30. A study of insects that attack the tobacco plant. (In coöperation with the U. S. Dept. Agr.) (See also Tobacco Substation, No. 20.)
31. Studies on the biology and control of the European pine shoot moth. (See also Forestry, No. 13.)
32. The biology and control of the potato flea beetle.
34. Tests of methods to control clothes moths.
35. The biology and control of the white apple leafhopper.
36. Methods for the control of onion thrips.
37. Substitutes for lead arsenate in orchard sprays.
38. The relation of rate of growth and pruning methods to the recovery of white pine to weevil injury. (In coöperation with the U. S. Dept. Agr.)
40. Studies of sprays and parasites for the control of the European corn borer. (In coöperation with the U. S. Dept. Agr.)
41. Studies on the corn ear worm. (In coöperation with the U. S. Dept. Agr.)
42. The biology and control of termites.
43. The spruce gall aphid.
44. A native elm bark beetle, *Hylurgopinus rufipes*, Eich.
45. Investigation of parasites of the Japanese beetle.
46. Methods for the control of the squash bug.
47. Value of derris dusts in the control of aphids.
48. Study of predators affecting the European red mite.
49. Adhesives for standard spray mixtures.

Control and Service

10. Inspection of orchards and nurseries.
11. Control of the gypsy moth. (In coöperation with the U. S. Dept. Agr.)
12. Elimination of the mosquito nuisance.
13. Inspection of apiaries.
19. Control of European corn borer. (In coöperation with the U. S. Dept. Agr.)
24. Control of the Asiatic beetle.
25. Control of the Japanese beetle. (In coöperation with the U. S. Dept. Agr.)
27. Rearing and distributing parasites of the Oriental fruit moth. (In coöperation with the Conn. Pomological Society.)

Forestry

1. Experimental plantations on a sandy tract at Rainbow.
   a. Comparison of many species of conifers and hardwoods, in pure stands and in combinations.
   b. Methods of management for those species that have survived.
   c. Studies on growth and habits of the several species.
2. Effect of thinning in white pine at Shaker Station.
3. Effect of thinning in hardwoods at Quassipaug Lake.
6. Studies of forest plantations throughout the State.
   a. Comparative growth of various species.
   b. Reasons for success or failure.
   c. Soil and other site factors necessary for success of each species.
10. An investigation of the distribution and growth of forest trees as influenced by soil conditions and other site factors.
12. A study of preservative treatments of native woods used for posts.
13. Studies on the biology and control of the European pine shoot moth. (See also Entomology No. 31.)
14. Studies on extensive control of the white pine weevil.

Control and Service

5. Distribution of forest planting stock. (In coöperation with the U. S. Dept. Agr.)
7. Control of white pine blister rust. (In coöperation with the U. S. Dept. Agr.)
15. Control of Dutch elm disease. (In coöperation with the U. S. Dept. Agr.)

Genetics

1. A genetic study of hereditary characters in corn involving their linkage relations and variability.
2. The effects of inbreeding and crossing upon corn.
3. Methods for the improvement of naturally cross-fertilized plants by selection in self-fertilized lines, with particular attention to field corn for grain and ensilage; alfalfa; and to some of the more important vegetable crops such as sweet corn for market gardening and canning, beets, cabbage, carrots, cucumbers, melons, onions, radishes, rutabagas, squash; and some fruits such as bush fruits and strawberries.
4. Methods for the improvement of naturally self-fertilized plants, with particular attention to tobacco, and vegetable crops such as lettuce, lima beans and tomatoes.
5. A study of variation and the effects of selection in strains of cross-fertilized and self-fertilized vegetables.

Soils

2. The physical and chemical characteristics of important soil types in relation to the nutritive response of tobacco and other crops when these soils are variously treated in the greenhouse.
3. Nutrient requirements of vegetable crops on important soil types used for market gardening in Connecticut.
4. A study of the physical, chemical and biological conditions of several soil types in natural mixed hardwoods and in planted coniferous forests.
5. Lysimeter studies of the drainage losses and other changes that occur in several soils under heavy fertilization as practiced for tobacco and vegetables.
6. Lysimeter studies of the composition of drainage water as affected by the forest floor.
7. The improvement of the nutritional status of unproductive forest soils.
8. The agronomic application of rapid chemical tests for estimating the nutritional factors of soil fertility.
9. The evaluation of various soil factors in terms of land use and types of farming.

Tobacco Substation

1. Fertilizer experiments—various sources and rates of nitrogen, phosphoric acid, potash, lime and magnesia.
4. Tobacco nutrition studies—the role of nitrogen, sulfur, potassium, phosphorus, calcium, manganese, boron, magnesium and other elements.
5. Improvement of Havana seed tobacco by selection. (In coöperation with the U. S. Dept. Agr.)
6. Improvement of Broadleaf tobacco.
7. Improvement of Cuban shade tobacco.
13. Preservative treatment of shade tent poles. (See Forestry, No. 12.)
17. Investigations in the curing of tobacco.
19. Diseases of tobacco.
20. A study of insects that attack the tobacco plant. (In coöperation with the U. S. Dept. Agr.) (See also Entomology, No. 30.)
22. Experiments on the irrigation of tobacco.
23. Studies on the rate of growth of tobacco.
24. The effect of harvesting tobacco at different stages of maturity.

All of which is respectfully submitted.

WILLIAM L. SLATE,
Director.

WHAT THE STATION CAN DO

Each mail brings to the Station requests for information and service, the range of subjects being almost without limit. Every effort is made to comply with these requests, even though they are outside the fields under investigation. This is one of the purposes for which the library is maintained. However, some of the letters request help that requires an intimate knowledge of live stock management and the like, and others ask us to make laboratory determinations for which we do not have the equipment or staff. Therefore it is helpful to publish from time to time a list of the subjects on which we are best equipped to furnish information and the kinds of samples we can accept.

The Station can furnish information on:

Fertilizers and fertilization.
Soils and their management.
The chemical composition of foods, drugs, insecticides and fungicides.
Insect pests of plants and their control.
Fungous and other diseases of plants and their control.
Sprays and spraying.
Fruits and fruit management.
Weeds and their control.
Forestry—all phases.
Care of shade trees, all phases.
Plant breeding.
Lawns, establishment and care.
Bees.
Mosquito elimination.
Tobacco.
Vegetables, especially varieties and strains.

Samples and specimens that can be analyzed, tested or identified:

Fertilizers.
Feeding stuffs.
Foods and drugs.
Milk—except for bacterial count.
Seeds.
Weeds and other plants.
Insects.
Diseased and injured plants.
Soils.

The Station does not furnish information on:

Live stock feeding and management, including poultry.
Animal diseases.
Household management.
Clothing.
Farm management.
Markets and marketing.
Requests for information on these subjects should be sent to the Connecticut State College, Storrs.

The Station cannot make analyses and examinations of:

Drinking water—apply to the State Board of Health, Hartford.
Milk for bacterial content—apply to the Dairy and Food Commissioner, Hartford.
Sick or dead poultry should be sent to the Animal Diseases Laboratory, Agricultural Experiment Station, Storrs.